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OF

The Entomological Society of America

VOLUME XXII, 1929

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CONTENTS OF VOLUME XXII.

CONTENTS OF No. 1.

GILLETTE, C. P. AND PALMER, M. A.—New Colorado Aphididæ 1
MORRISON, HAROLD—Some Neotropical Scale Insects Associated with Ants .. 33
MORGAN, ANN H.—The Mating Flight and the Vestigial Structures of the Stump-Legged Mayfly, *Campsurus segnis* Needham 61
MOTE, DON C.—The Reproductive System of the Warble Fly *Hypoderma bovis* DeGeer 70
DELONG, D. M. AND SLEESMAN, J. P.—New Genera and Subgenera from the Genus Deltocephalus. A Study of the Internal Male Genitalia of the American Species and Their Bearing upon Taxonomy 81
BEAMER, R. H.—Erythroneura (Homoptera, Cicadellidæ) from the Southwest. 115
LAWSON, PAUL B.—A Leafhopper Parasite—*Polynema saga* (Girault). (Hymenoptera, Mymaridæ) 130
JOHNSON, CHARLES W.—The Injury to Nestling Birds by the Larvæ of Protocalliphora 131
RILEY, WILLIAM A.—The Teaching of Medical Entomology 136
EUGENE AMANDUS SCHWARZ 142
Proceedings of the Twenty-third Annual Meeting, New York, N. Y., December 27th and 28th, 1928 144
Past Officers of the Entomological Society of America 159

CONTENTS OF No. 2.

BAERG, W. J.—Cocoon-Making by the Tarantula 161
DAKESSIAN, V. S.—Variation and Correlation on the Legs of the Honeybee .. 168
KARNY, H. H.—On a Collection of Gryllacrids and Tettigoniids (Orthoptera). Chiefly Javanese 175
STEINWEDEN, JOHN BENJAMIN—Bases for the Generic Classification of the Coccoid Family Coccidæ 197
HALLOCK, HAROLD C.—Notes on Methods of Rearing Sarcophaginæ (Diptera), and the Biology of Sarcophaga Latisterna Park 246
MANSON, ASA C., AND KNOWLTON, GEORGE F.—The Tribe Pemphigini (Aphididæ) in Utah 251
BROMLEY, S. W.—The Asilidæ of Cuba (Diptera) 272
STEINER, LOREN F.—Homologies of Tracheal Branches in the Nymph of Anax Junius Based on their Correlation with the Muscles They Supply .. 297
FORBES, WM. T. M.—The Genus Ecpantheria (Lepidoptera, Arctiidæ) 310
ABBOTT, CYRIL E.—The Comparative Morphology of the Spiracles of Two Species of Weevils 331
ESSIG, E. O.—Entomological Sentiment 335

264029

CONTENTS OF No. 3.

HOWARD, L. O.—*Aphelinus mali* and Its Travels 341

ANDREWS, E. A.—The Mound-Building Ant, *Formica exsectoides* F., Associated With Tree-Hoppers 369

ENGELHARDT, GEORGE P.—The Brooklyn and New York Entomological Societies, Past and Present 392

CAMPBELL, F. L.—The Detection and Estimation of Insect Chitin; and the Irrelation of "Chitinization" to Hardness and Pigmentation of the Cuticula of the American Cockroach, *Periplaneta americana* L. 401

FROST, S. W., AND DIETRICH HENRY—Coleoptera Taken from Bait-Traps 427

GRISWOLD, GRACE H.—On the Bionomics of a Primary Parasite and of Two Hyperparasites of the Geranium Aphid 438

BREAKEY, E. P.—Notes on the Natural Enemies of the Iris Borer, *Macronoctua onusta* Grote (Lepidoptera) 459

OSBORN, HERBERT—A New Genus and Three New Species of South American Cicadellidæ (Homoptera) 465

GILLETTE, C. P., AND PALMER, M. A.—Five New Aphididæ from Colorado 468

SALMAN, K. A.—Notes on the Immature Stages and Biology of a Birch Case-Bearer 480

CURRAN, C. H.—New Syrphidæ and Tachinidæ 489

PETRUNKEVITCH, ALEXANDER—Descriptions of New or Inadequately Known American Spiders 511

NEISWANDER, C. R., AND HUBER, L. L.—Height and Silking as Factors Influencing European Corn Borer Population 527

SMITH, M. R.—Descriptions of Five New North American Ants, with Biological Notes 543

MUTTKOWSKI, R. A.—Insect Nutrition and Metabolism 552

CONTENTS OF No. 4.

BEQUAERT, J.—The Folded-Winged Wasps of the Bermudas, with Some Preliminary remarks on Insular Wasp Faunæ 555

EWING, H. E.—A Synopsis of the American Arachnids of the Primitive Order Ricinulei 583

PAYNE, NELLIE M.—Absolute Humidity as a Factor in Insect Cold Hardiness with a Note on the Effect of Nutrition on Cold Hardiness 601

PLANK, H. K.—Natural Enemies of the Sugar Cane Moth Stalkborer in Cuba 621

SPENCER, HERBERT, AND STRACENER, CHARLES L.—Soil Animals Injurious to Sugarcane Roots 641

KRULL, WENDELL H.—The Rearing of Dragonflies From Eggs 651

RAU, PHIL—The Nesting Habits of the Bald-Faced Hornet, *Vespa maculata* 659

ALLEN, H. W.—An Annotated List of the Tachinidæ of Mississippi 676

WEST, LUTHER S.—A Preliminary Study of Larval Structure in the Dryopidæ 691

MALCOMSON, R. O.—Two New Species of Mallophaga 728

DUNAVAN, DAVID—A Study of Respiration and Respiratory Organs of the Rat-Tailed Maggot, *Eristalis arbustorum* L. (Diptera, Syrphidæ) 731

COCKERELL, T. D. A.—Some Bees of the Group Trachandrena, Robertson, (Hymenoptera: Andrenidæ) 754

HUNGERFORD, H. B.—A New Velia From Arizona, with Notes on Other Species (Hemiptera-Veliidæ) 759

LOBDELL, GLADYS HOKE—Two New Species of Eriococcus From Mississippi. (Homoptera: Coccoidea) 762

ALEXANDER, CHARLES P.—New Species of Crane Flies From South America. Part III. (Family Tipulidæ, Order Diptera) 768

Index to Volume XXII 789

ANNALS
OF
The Entomological Society of America

Volume XXII MARCH, 1929 Number 1

NEW COLORADO APHIDIDÆ.

C. P. GILLETTE AND M. A. PALMER,
Colorado Agricultural Experiment Station.

This paper deals with 16 apparently new species of aphids taken in Colorado, and belonging to the tribes *Callipterini* and *Aphidini* as far as the subtribe *Macrosiphina*.

Plocamaphis braggii, n. sp.*

Fundatrix.—Described from type specimen taken on root of *Salix* sp., at Boulder, Colorado, May 17, 1918, by L. C. Bragg.

Color: Head, pro- and mesothorax, cauda and anal plate dark dusky brown to blackish; rest of dorsum sordid tan, mottled with ferruginous; antennæ and legs dusky-brown throughout; cornicles concolorous with body.

Measurements: Body, 2.7 mm. by 1.5 mm.; hind tibiæ, 1.27 mm.; antennæ, 1.50 mm.; joints as follows: III, .42 mm.; IV, .23 mm.; V, .22 mm.; VI, .17 + .28 mm.; cornicles, .05 mm.; cauda, .13 mm.

Structural characters: Apterous; secondary sensoria present on antennal joint III only, 5 in number; all other characters as in apterous viviparous female.

Apterous Summer Viviparous Female.—(Plate I, Fig. 1; Plate II, Figs. 1 and 2). Described from type and 2 paratype specimens taken on root of *Salix* sp., at Boulder, Colorado, September 7, 1917, by L. C. Bragg.

Color: Body dusky-brown with blackish lateral spots on each somite, intersegmental areas lighter and slightly powdery, especially toward anterior and posterior portions of body; antennæ dark dusky-brown on proximal and distal joints, lighter in middle portion; legs sordid yellowish-brown, with distal one-half or two-thirds of femora dusky-brown, and tarsi and tips of tibiæ black or blackish.

Measurements: Body, 2.50 to 3 mm. by 1.5 mm.; hind tibiæ, 1.55 mm. (1.50 to 1.80 mm.); antennæ, 1.80 mm. (1.50 to 1.90 mm.); joints as follows: III, .43 mm. (.43 to .50 mm.); IV, .27 mm. (.25 to

*Measurements in parentheses mean limits of variation found in paratypes.

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.27 mm.); V, .29 mm. (.29 to .32 mm.); VI, .16 mm. (.16 to .18 mm.) + .40 mm. (.39 to .41 mm.); cornicles, .05 mm.; cauda, .15 mm.*

Structural characters: Secondary sensoria on antennal joint III only, 4 to 6 in number, small and arranged in an irregular row on posterior side of joint; hairs on body pointed, fine, .06 to .08 mm. long, quite numerous; on antennæ similar, .05 mm. long, numerous; same on cauda; cornicles inconspicuous, found only on close observation, slender, curved, smaller at distal end, .05 mm. in length, imbricated, without flanges; cauda inconspicuous, .07 mm. long, semicircular; frontal tubercles absent; lateral tubercles conspicuous on all abdominal segments except the 8th; ocular tubercles present but inconspicuous.

Alate Viviparous Female.—(Plate I, Fig. 2; Plate II, Figs. 3 and 4). Described from 4 specimens, one type and 3 paratypes taken on *Salix* sp., at Boulder, Colorado, September 7, 1917, by L. C. Bragg.

Color: Head and thorax black or blackish; abdomen yellowish-dusky-brown; antennæ dusky-brownish throughout; legs same color with distal half of femora, tips of tibiæ and entire tarsi black or blackish; cauda concolorous with body; stigmas yellowish-brown.

Measurements: Body, 3 mm. long; hind tibiæ, 1.6 mm. (1.4 to 1.65 mm.); antennæ, 1.8 mm. (1.70 to 1.90 mm.); joints as follows: III, .46 mm. (.41 to .47 mm.); IV, .28 mm. (.25 to .32 mm.); V, .32 mm. (.30 to .33 mm.); VI, .18 mm. + .32 mm. (.30 to .41 mm.); cornicles, .06 mm.; cauda, .15 mm., not projecting as far as the anal plate.

Structural characters: Secondary sensoria on joint III only, 10 to 14 in number in irregular row on posterior side of joint; fore wings with mediæ but once branched; hind wings with 2 cross veins; all other characters as in apterous viviparous female described above.

Male.—(Plate I, Fig. 3; Plate II, Fig. 8). Described from a single specimen taken on *Salix* in Fort Collins, Colorado, October 18, 1917, by L. C. Bragg.

Color: Entire dorsum yellowish-brown, shading into darker brown on head; antennæ pale dusky-brown; legs same color, except distal halves of femora, tips of tibiæ and entire tarsi, which are dusky to black; cornicles and cauda concolorous with body.

Measurements: Body, 2.3 mm.; hind tibiæ, 1.2 mm.; antennæ, 1.6 mm.; joints as follows: III, .40 mm.; IV, .22 to .30 mm.; V, .30 mm.; VI, .20 + .28 mm.

Structural characters: Apterous; secondary sensoria on antennal joint III, 14 to 17; IV, 6 to 7; V, 3 to 4; all other characters as in apterous viviparous female.

Oviparous Female.—(Plate I, Fig. 4; Plate II, Figs. 5, 6 and 7). Described from type specimen and one paratype taken on *Salix* sp., at Boulder, Colorado, November 5, 1917, by L. C. Bragg.

Color: Entire dorsum dark brown; antennæ and legs pale brownish-yellow; tarsi and distal parts of femora and tibiae dusky to black; venter of abdominal segments 6, 7 and 8 bearing short wax filaments.

Measurements: Body, 3 mm., rather elongate; hind tibiæ, 1.7 mm.; antennæ, 1.7 mm.; joints as follows: III, .47 mm. (.47 to .55 mm.);

*Measurements given for cauda include both hard and soft portions.

IV, .27 mm. (.25 to .42 mm.); V, .29 mm. (.29 to .37 mm.); VI, .18 mm. (.17 to .24 mm.) + .35 mm. (.29 to .37 mm.); cornicles, .06 mm.

Structural characters: Apterous; all characters same as in apterous viviparous female, except hind tibiæ, which are very slightly swollen and bear about 30 small, highly convex sensoria scattered along two-thirds of length.

Collections were taken on *Salix* sp. (root) by L. C. Bragg, all at Boulder, Colorado, except one at Fort Collins, Colorado.

Fundatrix.—One collection, May 17.
Apterous Viviparous Female.—Two collections, September 7 and 22.
Alate Viviparous Female.—One collection, September 7.
Male.—Two collections, October 18 and November 5.
Oviparous Female.—Three collections, September 22 to November 5.

Types in collection of the United States National Museum (Slide No. 41453); paratypes in Colorado Agricultural Experiment Station collection.

This species has been placed in the genus *Plocamaphis* only tentatively. It approaches also the genera *Melanoxantherium* and *Fullawaya*, but differs from all three in the absence of the second fork of the media. It differs from *Plocamaphis* in the lack of distinct flocculence, from *Melanoxantherium* in the absence of a flange on the cornicle, and from *Fullawaya* in the presence of minute cornicles. We hesitate, however, to erect a new genus on no other characters than the forking of the media and the absence of distinct flocculence.

Anuraphis ornata, n. sp.

Apterous Summer Viviparous Female.—(Plate I, Fig. 6; Plate II, Figs. 23 and 24). Described from one type and 4 paratype specimens taken on *Chrysothamnus graveolens*, at Fort Collins, Colorado, August 1, 1911, by L. C. Bragg.

Color: Dorsum of head dusky-brown, ground-color over rest of body, pinkish or flesh-color with transverse dashes of dusky on all segments, coalescing on 4th and 5th abdominal segments, and covering almost entire pronotum, reduced on 6th, 7th and 8th abdominal segments; dusky spots evident on lateral margins; entire dorsum covered with faint, white reticulations; cornicles, cauda and anal plate dusky to black; antennæ pale yellowish except the 1st, 2nd, 5th and 6th joints, which are dusky; legs pale yellowish, with tarsi, tips of tibiæ and distal half of femora dusky.

Measurements: Body, 1.5 mm. by 1.9 mm.; hind tibiæ, .66 mm.; antennæ, .90 mm.; joints as follows: III, .18 mm. (.12 to .20 mm.); IV, .10 mm. (.10 to .11 mm.); V, .10 mm. (.10 to .13 mm.); VI, .09 mm. + .12 mm. (.10 to .15 mm.); cornicles, .12 mm. (.10 to .12 mm.); cauda, .11 mm.

Structural characters: Secondary sensoria on joint III, 2 (1 to 2); on IV, 1; hairs on body fine, pointed, .03 to .05 mm., sparse and incon-

spicuous; similar on antennæ and legs; on cauda, .05 mm. and 4 to 5 in number on each side; cornicles cylindrical, slightly tapering distally, with slight flange, imbricated; frontal tubercles absent; lateral and ocular tubercles present.

Young.—(2nd instar). (Plate I, Fig. 7). Described from young born from apterous viviparæ described above.

Color: Entire dorsum pinkish, slightly dusky on head and slightly darker along median line of abdomen, perhaps from internal organs; antennæ and legs pale yellowish except tips, which are dusky. Length of body at this stage about 1 mm.

Alate Viviparous Female.—(Plate I, Fig. 5; Plate II, Figs. 20, 21 and 22). Described from one type and two paratypes taken on *Chrysothamnus graveolens* at Fort Collins, Colorado, August 28, 1917, by L. C. Bragg.

Color: Dorsum of head and thorax dark brown to black; abdomen yellowish-brown with dusky dashes on median and lateral portions of each segment; cauda concolorous with body; legs pale except the tarsi, tips of tibiæ and distal half of femora, which are dusky to black; antennæ blackish, except proximal part of joint III; cornicles dusky; stigmas dusky-yellowish.

Measurements: Body, 1.8 mm.; hind tibiæ, .66 to .70 mm.; antennæ, .80 to .86 mm.; joints as follows: III, .25 mm. (.22 to .29 mm.); IV, .13 mm. (.12 to .16 mm.); V, .13 mm. (.12 to .16 mm.); VI, .11 mm. + .14 mm. (.14 to .21 mm.); cornicles, .11 mm. (.10 to .12 mm.); cauda, .13 mm.

Structural characters: Secondary sensoria on joint III, 10 (7 to 10) in number; on IV, 1 (1 to 2) near distal end; all other characters as in apterous viviparæ; fore wings with mediæ twice branched; hind wings with 2 cross veins.

Male.—(Plate II, Fig. 25). Described from type taken October 22, 1914, and one paratype taken October 20, 1914, on *Chrysothamnus graveolens* at Fort Collins, Colorado, by L. C. Bragg.

Color: Impossible to determine, as specimens are mounted in balsam.

Measurements: Body, .85 to .90 mm.; hind tibiæ, .41 mm.; antennæ, .65 to .70 mm.; joints as follows: III, .18 mm.; IV, .09 mm.; V, .11 mm.; VI, .10 + .15 mm.; cornicles, .06 mm.; cauda, .05 mm.

Structural characters: Apterous; secondary sensoria on antennæ as follows: On III, 9; IV, 7 (3 to 8); V, 2 (2 to 5); VI, 3 (0 to 3); all other characters as in apterous viviparous female.

Oviparous Female.—(Plate II, Figs. 26, 27 and 28). Described from type taken on *Chrysothamnus graveolens* at La Porte (near Fort Collins), Colorado, November 8, 1916, by L. C. Bragg.

Color: Not determined, as specimen was mounted.

Measurements: Body, 1.80 mm.; hind tibiæ, .55 mm.; antennæ, .70 mm.; joints as follows: III, .18 mm.; IV, .09 mm.; V, .10 mm.; VI, .10 + .10 mm.; cornicles, .07 mm.; cauda, .07 mm.

Structural characters: Apterous; secondary sensoria absent on antennæ, a few large ones scattered over three-fourths of hind tibiæ; other characters as in viviparous female.

Collections were taken on *Chrysothamnus graveolens* and once on *Ratibida columnaris*, by L. C. Bragg, C. R. Jones, F. C. Hottes and the authors, mostly in the vicinity of Fort Collins, but also at Boulder and various localities quite widely distributed on the western slope of Colorado.

Fundatrix.—Not taken.
Apterous Viviparous Female.—Twenty-three collections, June 2 to October 20.
Alate Viviparous Female.—Ten collections, June 16 to August 28.
Male.—Two collections, October 11 to November 8.
Oviparous Female.—Three collections, October 11 to November 8.

Types in collection of the United States National Museum (Slide No. 41454); paratypes in collection of Colorado Agricultural Experiment Station.

This species is separated from *A. chrysothamnicola*, n. sp., by the color marking of the apterous viviparæ, the color of the young, the shape and length of the cornicles, the number of secondary sensoria, and the difference in size of the two forms.

Anuraphis chrysothamnicola, n. sp.

Apterous Summer Viviparous Female.—(Plate I, Fig. 10; Plate II, Figs. 9, 11 and 13).

Described from type specimen taken on *Chrysothamnus* sp. at Pueblo, Colorado, June 15, 1909, by E. Bethel, and 3 paratypes taken on *Chrysothamnus graveolens* near Fort Collins, Colorado, August 27, 1917, by L. C. Bragg.

Color: Dusky ocher-red on dorsum, lighter laterally, covered with delicate white reticulation; cauda concolorous with body; legs pale yellowish with femora dusky and tips of tibiæ and entire tarsi black; antennæ pale except first joint, tip of fifth, and entire sixth, which are dusky to black; cornicles dusky to black; eyes dark reddish brown.

Measurements: Body, 2 mm. by 1.3 mm.; hind tibiæ, 1 mm. (.85 to 1 mm.); antennæ, 1.26 mm.; joints: III, .34 mm. (.23 to .34 mm.); IV, .30 mm. (.22 to .28 mm.); V, .22 mm. (.19 to .22 mm.); VI, .12 mm. + .22 mm. (.21 to .24 mm.); cornicles, .22 mm. (.16 to .22 mm.); cauda, .11 mm.

Structural characters: Secondary sensoria none; hairs on body pointed, sparse, .03 to .04 mm. long; on antennæ similar, rather frequent and nearly erect; on legs same as on antennæ; on cauda curved, pointed, 3 to 4 on each side and 1 or 2 on dorsal part; cornicles occasionally showing a small hair on proximal half. Cornicles imbricated, cylindrical, slightly enlarged toward proximal ends, without evident flanges; cauda triangular, rather acute; frontal tubercles absent; lateral tubercles present on prothorax and first and seventh abdominal segments; ocular tubercles present.

Young, early instar.—(Plate I, Fig. 11). Described from examples born from apterous viviparous female paratypes described above.

Color: Dorsum pale greenish with darker green area, later tinged with reddish, on segments 1 to 5 of abdomen; vertex and cauda dusky; legs colorless with tarsi dusky to black; antennæ pale with dusky tips.

Alate Viviparous Female.—(Plate I, Fig. 12; Plate II, Figs. 10, 12 and 14). Described from one type and four paratypes taken on *Chrysothamnus graveolens* near Fort Collins, Colorado, June 9, 1915, by L. C. Bragg.

Color: Head and thorax black; abdomen dull blackish-green, darker on median and segmental lines, and dashes on dorsum of segments 7 and 8; cauda concolorous with body; legs pale except distal two-thirds of femora, tips of tibiæ and entire tarsi, which are dusky to black; antennæ pale with entire joints 1, 2 and 6, and tips of 3, 4 and 5 dusky to black; cornicles dusky to black; stigmas dusky yellowish, veins heavy brown with faint dusky border.

Measurements: Body, 2 to 2.2 mm. long; hind tibiæ, .90 to 1.00 mm.; antennæ, 1 to 1.25 mm.; joints: III, .30 mm. (.22 to .30 mm.); IV, .25 mm. (.22 to .25 mm.); V, .20 mm. (.19 to .22 mm.); VI, .11 mm. + .21 mm. (.17 to .21 mm.); cornicles, .12 mm. (.11 to .16 mm.); cauda, .14 mm.

Structural characters: Secondary sensoria 4 (3 to 7) in a single row on joint III; cauda slightly more acute than in apteræ; wings hyaline, mediæ twice branched, hind wings with 2 cross veins. Other characters as in apteræ.

Oviparous Female.—(Plate I, Fig. 8; Plate II, Figs. 15, 16 and 19). Described from 5 examples taken on *Chrysothamnus graveolens*, near Fort Collins, Colorado, October 12, 1914, by L. C. Bragg.

Color: Same as apterous viviparous female.

Measurements: Body, 2 mm.; hind tibiæ, .60 mm. (.60 to .70 mm.); antennæ, 1 mm.; joints: III, .23 mm. (.19 to .23 mm.); IV, .18 mm. (.15 to .19 mm.); V, .17 mm. (.14 to .17 mm.); VI, .10 mm. + .17 mm. (.16 to .20 mm.); cornicles, .09 mm. (.09 to .11 mm.).

Structural characters: Apterous; hind tibiæ slightly swollen along entire length and with about 12 very inconspicuous sensoria scattered along inner surface. All other characters as in apterous viviparæ.

Male.—(Plate I, Fig. 9; Plate II, Figs. 17 and 18). Described from type and paratype taken on *Chrysothamnus graveolens* near Fort Collins, Colorado, October 9, 1917, by L. C. Bragg.

Color: As in oviparæ.

Measurements: Body, 1.25 to 1.50 mm.; hind tibiæ, .70 mm.; antennæ, 1 mm.; joints: III, .24 mm. (.21 mm.); IV, .18 mm. (.19 mm.); V, .17 mm. (.18 mm.); VI, .10 mm. + .15 mm. (.17 mm.); cornicles, .04 mm.

Structural characters: Apterous; secondary sensoria, 5 to 11 on antennal joint III, 6 to 7 on joint IV, and 5 to 6 on joint V. All other characters as in oviparæ.

Collections all on *Chrysothamnus graveolens* near Fort Collins, Bellvue, Pueblo and Meeker, Colorado, by L. C. Bragg, F. C. Hottes, C. R. Jones, E. Bethel and the authors.

Apterous Viviparous Female.—Eighteen collections, from May 30 to September 24.
Alate Viviparous Female.—Six collections, from May 31 to July 10.
Oviparous Female.—Five collections, October 7 to October 29.
Male.—Four collections, October 9 to 29.

Types in collection of the United States National Museum (Slide No. 41455); paratypes in collection of Colorado Agricultural Experiment Station.

This species resembles *Aphis chrysothamni* Wil., but may be distinguished as follows: Absence of sensoria on joint IV of alate, the shorter cornicles, shorter antennal joint III, and longer unguis.

A closely related form was taken on *Chrysothamnus nauseosus* in Idaho. It differed in the presence of a distinct dark spot on the dorsum of the abdomen, which is apparent as a slightly dusky area even in the specimens mounted in balsam. The cornicles also are slightly longer than in the form above described. This form may constitute a distinct species.

Anuraphis flocculosa, n. sp.

Apterous Summer Viviparous Female.—(Plate III, Fig. 1; Plate IV, Figs. 1, 5 and 6). Described from type taken on *Lonicera* sp., at Fort Collins, Colorado, June 6, 1916, and 12 paratypes taken on same host and same locality June 6 to 16, 1916, all by L. C. Bragg.

Color: Entire dorsum blackish-brown, shading to dull orange along lateral edges of thorax and at bases of cornicles; antennæ and legs pale yellowish-brown with dusky tips; cornicles yellowish-brown to dusky.

Measurements: Body, 2.75 mm.; hind tibiæ, 1.30 mm. (1.20 to 1.50 mm.); antennæ, 2 mm. (1.90 to 2.40 mm.); joints as follows: III, .55 mm. (.50 to .68 mm.); IV, .33 mm. (.32 to .48 mm.); V, .30 mm. (.30 to .37 mm.); VI, .11 mm. (.11 to .15 mm.) + .45 mm. (.35 to .54 mm.); cornicles, .50 mm. (.50 to .68 mm.); cauda, .10 mm., broader than long.

Structural characters: Secondary sensoria on antennal joints small and round in shape; on joint III, 20 (10 to 20) in number, arranged in a very irregular double row along almost entire length of joint; on IV, 3 (0 to 3) on distal half of joint; hairs on body pointed, .04 mm. long, fine and sparse; on antennæ similar, .03 mm. long; on cauda slightly longer, curved and 3 on each side; cornicles marked with very fine transverse wrinkles difficult to see, and in mounted specimens appearing smooth, rather stout, broad at base, distinctly tapering towards distal end, with distinct flanges; frontal tubercles lacking; lateral tubercles weak; ocular tubercles present.

Alate Viviparous Female.—(Plate III, Fig. 2; Plate IV, Figs. 2, 3 and 4). Described from type taken on *Lonicera* sp., Fort Collins, Colorado, June 16, 1916, and 14 paratypes taken June 10 to 20, 1916, also one October 17, 1916, all on same host and in same locality, by L. C. Bragg.

Color: Head, thorax, cornicles, antennæ, femora, distal ends of tibiæ and entire tarsi black; abdomen clay-colored, entire dorsum heavily covered with powdery secretion.

Measurements: Body, 2.30 mm. long; hind tibiæ, 1.30 mm.; antennæ, 2.2 mm.; joints as follows: III, .61 mm. (.58 to .77 mm.); IV, .40 mm. (.37 to .48 mm.); V, .33 mm. (.32 to .37 mm.); VI, .12 mm. + .52 mm. (.48 to .65 mm.); cornicles, .40 mm. (.39 to .46 mm.); cauda, .11 mm.

Structural characters: Secondary sensoria on antennæ small, round and scattered, on joint III, about 40 in number; on IV, 8 (8 to 16); hairs and tubercles as in apterous viviparous female; cornicles cylindrical with flange; cauda longer and narrower than in apteræ, about as broad as long; forewings with mediæ twice branched; hind wings with 2 cross veins.

Oviparous Female.—(Plate IV, Figs. 8 and 9). Described from type and 3 paratypes taken on *Lonicera* sp., at Fort Collins, Colorado, November 15, 1916; 8 paratypes, November 17 and 24, 1916, and 6 others, October 28, 1914, all at Fort Collins, Colorado, by L. C. Bragg.

Color: Impossible to determine, as specimens were not observed until after mounting in balsam.

Measurements: Body, 3 mm.; hind tibiæ, 1.30 mm. (1 mm. to 1.30 mm.); antennæ, 1.85 mm. (1.40 to 2 mm.); joints as follows: III, .50 mm. (.40 to .56 mm.); IV, .33 mm. (.25 to .34 mm.); V, .30 mm. (.25 to .30 mm.); VI, .12 mm. + .44 mm. (.40 to .43 mm.); cornicles, .60 mm. (.40 to .60 mm.).

Structural characters: Secondary sensoria on antennal joint III only, 7 (3 to 8) in number; other characters as in apterous viviparous female, except hind tibiæ, which are slightly swollen along entire length and thickly covered with sensoria of medium size.

Male.—(Plate IV, Fig. 7). Described from type taken at Fort Collins, Colorado, October 28, 1914, by L. C. Bragg.

Color: Not determined, as specimens are mounted in balsam.

Measurements: Body, 1.70 mm. long; hind tibiæ, 1.40 mm.; antennæ, 2.30 mm.; joints as follows: III, .65 mm.; IV, .49 mm.; V, .38 mm.; VI, .15 + .63 mm.; cornicles, .20 mm.; cauda, .08 mm.

Structural characters: Alate; secondary sensoria small, round and scattered throughout entire length of joints; on III, 42; IV, 21; V, 15 in number; all other characters as in alate viviparous female.

Collections were taken on *Lonicera* sp. at Fort Collins, Colorado, by L. C. Bragg.

Apterous Summer Viviparous Female.—Six collections, from June 6 to July 20.
Alate Viviparous Female.—Nine collections, from June 10 to October 28.
Oviparous Female.—Five collections, October 13 to November 24.
*Male.**—One collection, October 28.

Types in collection of the United States National Museum (Slide No. 41456); paratypes in collection of Colorado Agricultural Experiment Station.

This species is very peculiar on account of the unusually long cornicles and very short cauda, as well as the heavy pulverulence or flocculence.

*The slide containing this male and also six oviparous females is marked "*Symphoricarpos*," but this is probably an error, as all other records have been on *Lonicera*.

Anuraphis senecioradicis, n. sp.

Apterous Summer Viviparous Female.—(Plate III, Fig. 3; Plate IV, Figs. 11, 12 and 13). Described from type and 5 paratypes taken on root of *Senecio* sp. at Fort Collins, Colorado, September 4, 1918, also 4 paratypes taken August 29, 1918; 6 others, August 17, 1912, same host and locality as type, all by L. C. Bragg.

Color: Entire dorsum dusky blue-green, shading to brownish on head, covered with slight pulverulence; legs and antennæ dusky to blackish throughout; cornicles black.

Measurements: Body, 2.80 mm. by 1.70 mm.; hind tibiæ 1.05 mm.; antennæ, 1.25 mm.; joints as follows: III, .28 mm. (.26 to .31 mm.); IV, .22 mm. (.20 to .25 mm.); V, .20 mm. (.18 to .22 mm.); VI, .14 mm. (.14 to .18 mm.) + .27 mm. (.25 to .32 mm.); cornicles, .11 mm. (.10 to .14 mm.); cauda, .18 mm.

Structural characters: Secondary sensoria on antennal joints round, variable in size; on III, 5 (1 to 5) in number; IV, 5 (1 to 5); hairs fine, pointed, .04 to .05 mm. long, moderately numerous on body, antennæ and legs; hairs on cauda curved, .08 mm. long and 7 on each side; cornicle imbricated, cylindrical, without evident flange; cauda obtusely conical, with only a very slight suggestion of constriction; frontal tubercles lacking; lateral tubercles present on all segments anterior to cornicles, but not observed posteriorly; ocular tubercles present.

Alate Viviparous Female.—(Plate III, Fig. 4; Plate IV, Figs. 10 and 14). Described from type and 3 paratypes taken September 4, 1918, on root of *Senecio* sp., at Fort Collins, Colorado, also 14 paratypes taken August 29, 1918, 3 taken August 17, 1912, and one taken October 22, 1913, same host and locality, all by L. C. Bragg.

Color: Head and thorax black, dorsum of abdomen bluish-green, dusky on lateral areas of all segments and dusky dashes on dorsum of 7th and 8th; antennæ and legs dusky to black throughout.

Measurements: Body, 2.2 mm.; hind tibiæ, 1 mm. (.90 to 1.05 mm.); antennæ, 1.20 mm.; joints as follows: III, .25 mm. (.24 to .28 mm.); IV, .20 mm. (.19 to .23 mm.); V, .19 mm. (.15 to .20 mm.); VI, .14 mm. + .29 mm. (.24 to .32 mm.); cornicles, .10 mm. (.09 to .11 mm.); cauda, .14 mm.

Structural characters: Secondary sensoria on antennal joints round, medium in size, arranged in rather irregular row on posterior side of joints; on III, 5 (5 to 8); on IV, 4 (1 to 6); hairs, cornicles and tubercles as in apterous viviparous female; cauda similar to that of apterous, but slightly narrower; fore wings with mediæ twice forked; hind wings with two cross veins.

Male.—(Plate IV, Fig. 15). Described from type taken on root of *Senecio* sp., at Fort Collins, Colorado, by L. C. Bragg.

Color: Not determined, as specimen was not examined before mounting in balsam, but legs and antennæ still show dark coloration throughout.

Measurements: Body, 1.20 mm.; hind tibiæ, .70 mm.; antennæ, .90 mm.; joints as follows: III, .20 mm., almost completely coalesced

with IV; IV, .17 mm.; V, .15 mm.; VI, .10 mm. + .21 mm.; cornicles, .06 mm.; cauda, .09 mm.

Structural characters: Apterous; secondary sensoria on antennæ small and round and arranged in an irregular row on posterior side of joints, on III, 5; on IV, 4; on V, 3 or 4; hairs, cornicles, and tubercles as in apterous viviparous female.

Oviparous Female.—(Plate IV, Figs. 16 and 17). Described from type and 3 paratypes taken on root of *Senecio* sp., at Fort Collins, Colorado, October 22, 1913, by L. C. Bragg.

Color not determined before mounting in balsam, but legs and antennæ appear dark throughout.

Measurements: Body, 2.5 mm.; hind tibiæ, 1 mm.; antennæ, 1.25 mm.; joints as follows: III, .30 mm. (.25 to .30 mm.); IV, .16 mm. (.15 to .19 mm.); V, .16 mm. (.15 to .18 mm.); VI, .12 mm. + .26 mm.; cornicles, .10 mm. (.08 to .10 mm.).

Structural characters: Secondary sensoria on antennæ small and round, on III, 3; IV, 2; hind tibiæ slightly swollen beyond the middle, and bearing 13 sensoria (10 to 24); all other characters as in apterous viviparous form.

Collections were made on *Senecio* sp. and *Senecio spartioides*, at Fort Collins, Colorado Springs, Grand Mesa, northern Routt County, and Virginia Dale, Colorado, by L. C. Bragg and C. R. Jones.

Apterous Viviparous Female.—Ten collections, July 25 to September 21.
Alate Viviparous Female.—Five collections, August 16 to September 21.
Male.—One collection, October 30.
Oviparous Female.—One collection, October 30.

Types in collection of the United States National Museum (Slide No. 41457); paratypes in collection of Colorado Agricultural Experiment Station.

This species is separated from *A. lugentis* Will., which is also a dark green aphid on *Senecio* roots, by the much shorter cornicles, only one-half as long, the longer antennal filament, and the apterous condition of the male which is alate in *lugentis*.

It is separated from *A. senecio* Swain described without secondary sensoria in apteræ, pale green in color, and with about 22 sensoria on joint III of the antennæ in the alate form.

It differs from *A. middletonii* Thos. by the longer spur and cornicles.

Anuraphis debilicornis, n. sp.

Apterous Summer Viviparous Female.—(Plate IV, Figs. 20 and 21). Described from type and 4 paratypes taken on *Helianthus* sp. at Fort Collins, Colorado, July 20, 1912; also 6 other paratypes taken September 8, 1915, same host and locality, all by L. C. Bragg.

Color: Impossible to determine, as specimens are mounted in balsam.

Measurements: Body, 2 mm.; hind tibiæ, 1 mm.; antennæ, 1.10 mm.; joints as follows: III, .35 mm. (.26 to .35 mm.); IV, .17 mm. (.15 to .18 mm.); V, .16 mm. (.14 to .17 mm.); VI, .12 mm. + .17 mm. (.16 to .19 mm.); cornicles, .14 mm. (.10 to .14 mm.); cauda, .15 mm.; individuals without sensoria had shorter joints as follows: III, .20 to .26 mm.; IV, .13 to .16 mm.; V, .12 to .15 mm.; VI, .10 to .12 mm. + .14 to .19 mm.; cornicles, .08 to .10 mm.*

Structural characters: Secondary sensoria on antennæ rather tuberculate and arranged in 2 irregular rows, on III, 15 (1 to 20); IV, 5 (1 to 5); some individuals lack secondary sensoria;* hairs fine, pointed, .05 mm. long, and sparse on body and antennæ, more numerous on tibiæ, .03 to .04 mm. long; on cauda, .07 mm. long, curved and 8 on a side; cornicles imbricated, cylindrical, and without flanges; frontal tubercles lacking; lateral tubercles present on prothorax, and 1st and 7th abdominal segments; ocular tubercles present; cauda bluntly conical without constriction.

Alate Viviparous Female.—(Plate III, Fig. 6; Plate IV, Figs. 18, 19 and 27). Described from type and 4 paratypes taken on *Helianthus* at Fort Collins, Colorado, July 5, 1915, by L. C. Bragg.

Color: Head and thorax dull black, dorsum of abdomen and inter-segmental membranes on pronotum dark olive-buff to buffy-olive, marked with dusky on lateral areas of abdominal segments 2, 3 and 4, and slender dashes on dorsum of segments 7 and 8; cauda, cornicles and antennæ dusky; legs dusky to black except proximal half to two-thirds of tibiæ, which are pale yellowish; stigmas pale brownish.

Measurements: Body, 2.60 mm.; hind tibiæ, 1.10 mm.; antennæ, 1.10 mm.; joints as follows: III, .35 mm.; IV, .18 mm.; V, .17 mm.; VI, .13 mm. + .19 mm.; cornicles, .10 mm.; cauda, .14 mm.

Structural characters: Secondary sensoria on antennæ round and tuberculate, on III, 28 (20 to 30); IV, 7; V, 3 (1 to 3); hairs, cornicles and tubercles as in apterous viviparous form; cauda, slightly more elongate, but blunt and without evident constriction; fore wings with mediæ twice branched; hind wings with two cross veins.

Male.—(Plate IV, Figs. 22 and 23). Described from type and 2 paratypes taken on *Helianthus annuus*, September 24, 1911, at Fort Collins, Colorado, and 3 paratypes taken on same host at Loveland, Colorado, all by L. C. Bragg.

Color: Not determined, as specimens are mounted in balsam.

Measurements: Body, 1.50 mm.; hind tibiæ, .73 mm.; antennæ, .95 mm.; joints as follows: III, .27 mm.; IV, .15 mm.; V, .14 mm.; VI, .11 mm. + .18 mm.; cornicles .05 mm.; cauda, .11 mm.

Structural characters: Alate; secondary sensoria on antennal joints small and round; on III, 36; on IV, 19; on V, 8 to 10; (on VI, 1 present in some paratypes); all other characters as in alate viviparous females.

*The individuals without sensoria were taken in the same collections with the others and appeared in all other respects to be the same species. These forms appeared in greatest numbers in late summer and fall collections, and quite rarely in spring and early summer, while the opposite was the case with the form with sensoria.

Oviparous Female.—(Plate III, Fig. 5; Plate IV, Figs. 24, 25 and 26). Described from type and 2 paratypes taken September 17, 1915, at Loveland, Colorado, also 3 others taken at Fort Collins, Colorado, September 24, 1911, on *Helianthus annuus*, all by L. C. Bragg.

Color: Entire dorsum dusky olive-green to brownish; antennæ dusky, except third joint which is pale; legs dusky except proximal two-thirds or three-quarters of 1st and 2nd pairs of tibiæ, which are pale yellowish, and same portions of hind tibiæ which are brownish; cornicles and cauda dusky.

Measurements: Body, 1.77 mm.; hind tibiæ .70 mm. (.65 to .80 mm.); antennæ, .87 mm.; joints as follows: III, .20 mm.; IV, .12 mm.; V, .12 mm.; VI, .11 mm. + .16 mm.; cornicles, .08 mm.; cauda, .15 mm.

Structural characters: Apterous; secondary sensoria absent on antennæ; hind tibiæ slightly swollen except on distal one-fourth, and bearing rather large convex sensoria scattered over entire swollen area; other characters as in apterous viviparous form.

Collections were taken on *Helianthus annuus* at Fort Collins and Loveland, Colorado, by L. C. Bragg.

Apterous Viviparous Female.—Seven collections, July 2 to September 26.
Alate Viviparous Female.—Eight collections, July 5 to September 24.
Male.—Five collections, September 8 to 29.
Oviparous Female.—Three collections, September 17 to 29.

Types in collection of the United States National Museum (Slide No. 41458); paratypes in collection of Colorado Agricultural Experiment Station.

This species differs from *Aphis helianthi* Monell, according to metatype slides received from Monell, with which it has sometimes been confused, by the conical cauda, the much shorter cornicles, the much more numerous and more tuberculate sensoria on joint III of antenna, as well as presence of sensoria on joints IV and V of the alate viviparous female, and the presence of sensoria on antennæ of apterous viviparous females.

Siphonatrophia gravida (Knowlton).*

Fundatrix.—(Plate III, Fig. 7; Plate IV, Fig. 28). Described from type and 1 paratype taken on *Sabina scopulorum* at Fort Collins, Colorado, April 21, 1919, by L. C. Bragg.

* In preparing this paper this species was described as new, but after the manuscript was in the hands of the printer, we received from Professor Knowlton a separate of his paper in The Florida Entomologist on "A New Juniper Aphid from Utah." As Professor Knowlton's species seems to be identical with ours, we have accepted his specific name (*gravidis*), but have retained the generic name *Siphonatrophia*, and our discussion of the relation of our species to this genus. It might seem from Knowlton's description of wing venation that we were dealing with a different species, but two out of three cotypes which he sent us had the media twice forked in one wing and once forked in the other, indicating the variability of this character.

Color: Light cedar-green, tinged with dusky on head, shining; terminal joints of antennæ, tips of preceding joints, tarsi, and tips of tibiæ dusky; remainder of antennæ and legs colorless; cauda pale greenish; cornicles concolorous with body.

Measurements: Body to base of cauda, 1.25 mm.; hind tibiæ, .40 mm.; (.35 mm.); antennæ, .46 mm. (.40 mm.); joints as follows: III, .14 mm.; IV, .06 mm.; V, .10 mm. + .06 mm. (III, .15 mm.; IV, .09 mm. + .06 mm.); cornicles, mere rings or .01 mm.; cauda, .17 mm.

Structural characters: Apterous; dorsum highly arched, venter flattened; cauda directed ventrally; antennal joints III and IV were anastomosed in the type, and joints III, IV and V in the paratype; other characters as in apterous summer viviparæ.

Young.—(1st instar), (Plate III, Fig. 8). Described from examples born of fundatrices described above.

Entire dorsum pale yellowish-green; legs and antennæ colorless. Cauda, short, triangular, and dorsum not pronouncedly convex.

Apterous Summer Viviparous Female.—(Plate IV, Fig. 32). Described from type and 1 paratype taken May 9, 1919, by L. C. Bragg, and 8 others August 8, 1928, on *Sabina scopulorum* at Fort Collins, Colorado, by the junior author.

Color: Cedar-green, exactly imitating the cedar scales on which it feeds; shining paler green on head; tips of antennæ and tarsi slightly dusky, remainder of antennæ and legs colorless; cauda pale green; cornicles concolorous with body.

Measurements: Body to base of cauda, 1.40 mm. (1 mm.); hind tibiæ, .40 mm.; antennæ, .60 mm.; joints as follows: III, .12 mm.; IV, .09 mm. (.06 to .09 mm.); V, .10 mm. (.08 to .11 mm.); VI, .10 mm. + .10 mm.; cornicles, .01 mm.; cauda, .17 mm.

Structural characters: Secondary sensoria absent on antennæ; hairs apparently absent on body and antennæ; on legs very short, .01 mm., and very sparse; on cauda, .03 mm. long, slightly curved and 5 or 6 on a side; cornicles mere pores on slightly raised base, .01 mm. high; cauda broad, long conical, rounded at tip, without constriction at base; frontal tubercles absent; lateral tubercles not evident; ocular tubercles present but inconspicuous.

Alate Viviparous Female.—(Plate III, Fig. 9; Plate IV, Figs. 29, 30 and 31). Described from type taken May 9, 1919, by L. C. Bragg, and 2 paratypes taken August 8, 1928, by the junior author all on *Sabina scopulorum* at Fort Collins, Colorado.

Color: Meso- and metathorax brown, rest of body cedar-green; legs and antennæ pale throughout, except tarsi and tips of tibiæ which are tinged with dusky; cauda pale greenish; cornicles concolorous with body; stigmas pale.

Measurements: Body to base of cauda, 1.40 mm.; hind tibiæ, .50 mm.; antennæ, .66 mm.; joints as follows: III, .20 mm.; IV, .10 mm.; V, .12 mm.; VI, .10 mm. + .12 mm.; cornicles .01 mm.; cauda, .17 mm.

Structural characters: Not arched dorsally as apterous; secondary sensoria on joint III, 6, round, and arranged in a single row; one small sensorium near tip of IV; fore wings with mediæ only once branched; hind wings with 2 cross veins; other characters as in apterous viviparæ.

Oviparous Female.—(Plate III, Figs. 10 and 11; Plate IV, Figs. 33 and 34). Described from type taken October 11, 1920, by senior author and 20 paratypes taken November 6, 1919, by L. C. Bragg, all on *Sabina scopulorum* at Fort Collins, Colorado.

Color: Same as in apterous viviparæ described above except hind tibiæ, which are dusky throughout entire length.

Measurements: Body to base of cauda, 1.43 mm.; hind tibiæ, .45 mm.; antennæ, .63 mm.; joints as follows: III, .16 mm. (.14 to .18 mm.); IV, .08 mm.; V, .10 mm.; VI, .09 mm. + .09 mm.; cornicles and cauda as in viviparæ.

Structural characters: Apterous, division between antennal joints III and IV, rather indistinct on antenna on one side, distinct on other antenna; a few paratypes with III and IV completely anastomosed; majority with division rather faint but evident; hind tibiæ much swollen and thickly strewn with flat sensoria over almost entire length; other characters as in apterous viviparæ.

Egg.—(Plate III, Fig. 12). Described from eggs laid by oviparæ described above.

Color: Black, shining, some time after being laid. Measurements .66 mm. by .30 mm.

Apterous Male.—(Plate III, Fig. 13). Described from type taken in same collection as oviparæ paratypes.

Color: Impossible to determine as specimens are mounted in balsam; antennæ and legs appear dark throughout.

Measurements: Body to base of cauda, .95 mm.; hind tibiæ, .48 mm.; antennæ, .70 mm.; joints as follows: III, .26 mm.; IV, .16 mm.; V, .14 mm.; VI, .07 mm. + .07 mm.; cauda, .11 mm.

Structural characters: Secondary sensoria on antennæ arranged in irregular row on posterior side of joints as follows: III, 10; IV, 8; V, 6; other characters as in apterous viviparæ.

Alate Male.—(Plate IV, Fig. 35). Described from type taken on *Sabina scopulorum*, at Fort Collins, Colorado, October 11, 1920, by the senior author, along with oviparous type.

Color: Impossible to determine as specimen is mounted in balsam; antennæ and legs appear dusky throughout.

Measurements: Same as apterous male.

Structural characters: Wings as in alate viviparæ, except that they are broader in proportion to their length, and in this single example at hand only one cross vein is visible in the hind wing. (Wings, however, are poorly mounted); antennæ as in apterous male; other characters as in alate viviparæ.

Collections, all on tips of twigs of *Sabina scopulorum*, at Fort Collins, Colorado, by L. C. Bragg and the authors, were made as follows:

Fundatrix.—One collection, April 21, 1919.
Apterous Summer Viviparous Female.—Three collections, May 9 to September 25.
Alate Viviparous Female.—Two collections, May 9 and August 8.
Oviparous Female.—Two collections, October 11 and November 6.
Apterous Male.—One collection, November 6.
Alate Male.—One collection, October 11.

This species was quite difficult to find due to protective coloration, the closely appressed position and shape, and the solitary habit. The alatæ appeared to be very scarce.

This species is placed tentatively in the genus *Siphonatrophia* Swain on account of the very striking similarity in body form to the type species of the above genus. Indeed it almost seems doubtful that our form is a distinct species. However, strangely enough, the only points of difference lie in the very characters stressed by Swain in his characterization of the genus, namely, the number of antennal joints and the wing venation. The alatæ of our form present the full number of antennal joints and have once branched mediæ. The apterous females, especially the fundatrices and oviparæ, show a decided tendency to reduction in number of antennal joints. Accordingly, the basis for erection of a new genus for so similar a species seems to the authors to be insufficient at present.

Aphis laciniariæ, n. sp.

Apterous Summer Viviparous Female.—(Plate V, Fig. 2; Plate VI, Figs. 1 and 1a). Described from type and 3 paratypes taken August 28, 1916, also 7 paratypes taken August 8, 1916, at Fort Collins, Colorado; 5 paratypes taken July 5, 1911, 9 taken July 5, 1912, and 12 taken August 15, 1912, at Boulder, Colorado, all on *Laciniaria* (*Liatris*) *punctata*, by L. C. Bragg.

Color: Impossible to determine as specimens are mounted in balsam, but tarsi, tips of tibiæ and of antennæ appear dusky; cornicles show slight signs of having been dusky.

Measurements: Body, to base of cauda, 1.40 mm.; hind tibiæ, .43 mm. (.40 to .50 mm.); antennæ, .75 mm.; joints as follows: III, .15 mm. (.12 to .18 mm.); IV, .11 mm. (.10 to .13 mm.); V, .11 mm. (.09 mm. to .12 mm.); VI, .08 mm. + .20 mm. (.14 to .20 mm.); cornicles, .14 mm. (.12 to .19 mm.); cauda, .09 mm.

Structural characters: Secondary sensoria absent; hairs on body pointed, minute, .01 mm. long, and very sparse, similar on antennæ and tibiæ, on the latter noticeable only on inner side; on cauda curved, about .05 mm. long, and 3 on each side; cornicles imbricated, cylindrical, without evident flanges; cauda acutely triangular with slight constriction usually evident near base; frontal tubercles absent; lateral tubercles present but blunt and inconspicuous; ocular tubercles present.

Alate Viviparous Female.—(Plate V, Fig. 1; Plate VI, Figs. 2 and 3). Described from type and 9 paratypes taken August 28, 1916, one paratype taken August 8, 1916, at Fort Collins, Colorado, also 5 paratypes taken July 5, 1911, 3 on July 5, 1912, and 12 others taken August 15, 1912, at Boulder, Colorado, all on *Laciniaria* (*Liatris*) *punctata*, by L. C. Bragg.

Color: Impossible to determine as specimens are mounted in balsam, but head, thorax, antennæ, tarsi and tips of tibiæ appear dusky to black; cornicles show slight duskiness.

Measurements: Body, 1.20 mm. to base of cauda; hind tibiæ, .55 mm. (.45 to .60 mm.); antennæ, .85 mm.; joints as follows: III, .18 mm. (.13 to .18 mm.); IV, .13 mm. (.09 to .13 mm.); V, .13 mm. (.09 to .13 mm.); VI, .09 mm. + .21 mm. (.16 to .21 mm.); cornicles, .15 mm. (.11 to .15 mm.); cauda, .10 mm.

Structural characters: Secondary sensoria on antennæ round and arranged in a single row on posterior side of joint, on joint III only, 4 (4 to 8) in number; hairs, cornicles, cauda and tubercles as in apterous viviparæ; fore wings with mediæ twice branched; hind wings with two cross veins.

Oviparous Female.—(Plate VI, Fig. 4). Described from type and 2 paratypes taken October 5, 1916, at Fort Collins, Colorado, on *Laciniaria* (*Liatris*) *punctata*, by L. C. Bragg.

Color: Impossible to determine as specimens are mounted in balsam.

Measurements: Body, to base of cauda, 1.10 mm.; hind tibiæ, .37 mm.; antennæ, .65 mm.; joints as follows: III, .12 mm.; IV, .10 mm.; V, .09 mm.; VI, .08 mm. + .16 mm.; cornicles, .13 mm.; cauda, .10 mm. (.07 to .09 mm.).

Structural characters: Apterous; hind tibiæ slightly swollen, with about 10 rather large round, slightly convex sensoria scattered along approximately entire length of tibiæ; cauda not as acutely triangular as in viviparæ; all other characters as in apterous viviparæ.

Collections were made on *Laciniaria punctata*, in northern part of Colorado east of the Rocky Mountains, by L. C. Bragg, as follows:

Apterous Summer Viviparous Female.—Six collections, July 5 to September 7.
Alate Viviparous Female.—Five collections, July 5 to August 28.
Oviparous Female.—Two collections, September 13 to October 5.

Types in collection of the United States National Museum (Slide No. 41459); paratypes in collection of Colorado Agricultural Experiment Station.

Aphis fraseræ, n. sp.

Apterous Summer Viviparous Female.—(Plate V, Fig. 4; Plate VI, Figs. 5, 6 and 7). Described from type and one paratype taken on *Frasera speciosa*, near Bellvue, Colorado, June 26, 1916, 8 other paratypes taken May 28, 1916, and 6 others taken August 4, 1912, on same host as above near Boulder, Colorado, all by L. C. Bragg.

Color: Head dark dusky-brown, rest of body dull yellowish-green, mottled with dull blackish-green; cauda dusky; legs pale brownish, with distal two-thirds of second and third pairs of femora, tips of tibiæ, and entire tarsi black or blackish; antennæ blackish except base of joint III, which is pale; cornicles black.

Measurements: Body to base of cauda, 2 mm.; hind tibiæ, .83 mm.; antennæ, 1.16 mm.; joints as follows: III, .33 mm. (.27 to .34 mm.); IV, .19 mm. (.16 to .23 mm.); V, .19 mm. (.14 to .19 mm.); VI, .12 mm.

+ .23 mm. (.18 to .25 mm.); cornicles .28 mm. (.22 to .30 mm.); cauda, .15 mm.

Structural characters: Antennæ without sensoria; hairs pointed, on body .05 mm. long, rather sparse; on antennæ and legs similar but fairly numerous; on cauda .06 to .07 mm., curved, 5 on each side; cornicles cylindrical or somewhat tapering, imbricated, with flanges, cauda blunt and parallel sided with slight constriction near base; frontal tubercles absent; lateral tubercles well developed; ocular tubercles present.

Two examples (Plate VI, Fig. 5a) taken in the same collection as the type bear 9 to 14 small, round, scattered sensoria on joint III of the antennæ, and one of them bears 2 on joint IV. Joint III measures .36 mm. in these examples, which is slightly longer than in the type and paratype. Otherwise no differences were noted to justify their determination as separate species.

Alate Viviparous Female.—(Plate V, Fig. 3; Plate VI, Figs. 8 and 9). Described from type and 16 paratypes taken on *Frasera speciosa* near Bellvue, Colorado, June 13, 1916, by L. C. Bragg.

Color: Abdomen yellowish-green, mottled with darker green; head, thorax, cornicles, cauda, tarsi and tips of tibiæ black; distal two-thirds of 2nd and 3rd pairs of tibiæ, entire antennæ and lateral areas on all abdominal segments dusky to blackish; remainder of legs sordid honey-yellow; stigma pale dusky-yellow.

Measurements: Body, to base of cauda, 1.66 mm.; hind tibiæ, .83 mm.; antennæ 1.12 mm.; joints as follows: III, .30 mm.; IV, .18 mm.; V, .17 mm.; VI, .13 mm. + .23 mm.; cornicles .20 mm.; cauda, .14 mm.

Structural characters: Secondary sensoria on antenna round, irregular in size and on III scattered over posterior half of joint, 24 in number; on IV, 1 to 7; fore wings with mediæ twice branched; hind wings with two cross veins; other characters as in apterous viviparæ.

Collections were made on flower pedicels of *Frasera speciosa* in north central Colorado in altitudes from 6000 to 9000 feet, by L. C. Bragg and the authors as follows:

Apterous Summer Viviparous Female.—Nine collections, from May 28 to September 2.

Alate Viviparous Female.—Five collections, June 9 to August 12.

This is quite a common species. Types in collection of the United States National Museum (Slide No. 41460); paratypes in collection of Colorado Agricultural Experiment Station.

Aphis cercocarpi, n. sp.

Apterous Summer Viviparous Female.—(Plate V, Fig. 5; Plate VI, Figs. 10, 11 and 14). Described from type and one paratype taken on *Cercocarpus parvifolius* at Ingleside, Colorado, August 15, 1911, by L. C. Bragg, also about 20 other paratypes all taken on the same host, in distorted leaves at Loveland, Colorado, and hills* near Bellvue, Colorado, by L. C. Bragg, F. C. Hottes and the authors.

*Altitude 8,000 feet.

Color: Entire dorsum greenish-black, shining; antennæ and legs pale with tips of antennæ distal ends of femora and tibiæ and entire tarsi black or blackish; cornicles and cauda dark to black.

Measurements: Body, 1.30 mm. to base of cauda; hind tibiæ .70 mm.; antennæ, .95 mm.; joints as follws: III, .26 mm. (.20 to .30 mm.); IV, .17 mm. (.11 to .19 mm.); V, .14 mm. (.10 to .15 mm.); VI, .10 mm + .20 mm. (.18 to .24 mm.); cornicles .16 mm. (.12 to .18 mm.); cauda .12 mm.

Structural characters: Secondary sensoria absent; hairs on body pointed, .03 mm. long, inconspicuous and sparse; same on antennæ, slightly more numerous on legs; on cauda curved, three on each side; cornicles cylindrical or slightly tapering, slightly imbricated, with distinct flanges; cauda rather globular in shape with distinct constriction near base; frontal tubercles lacking; lateral tubercles evident on prothorax and 1st and 7th abdominal segments; ocular tubercles present.

Alate viviparous Female.—(Plate V, Fig. 6; Plate VI, Figs. 12 and 13). Described from type taken on *Cercocarpus parvifolius* on hills near Bellvue,* Colorado, August 21, 1922, by F. C. Hottes, in distorted leaves.

Color: Head and thorax black; abdomen blackish-green; antennæ pale on proximal portions of joints III and IV, remainder dusky to black; legs pale with distal halves of femora dusky and tarsi and tips of tibiæ blackish; cornicles and cauda dusky; wing veins black; stigmas yellowish.

Measurements: Body, to base of cauda, 1.33 mm.; hind tibiæ, .67 mm.; antennæ, .85 mm.; joints as follows: III, .25 mm.; IV, .12 mm.; V, .12 mm.; VI, .10 mm. + .19 mm.; cornicles, .10 mm.; cauda, .08 mm.

Structural characters: Secondary sensoria on antennal joint III only, 17 in number, large, round and scattered over entire joint; fore wings with mediæ twice branched, second fork twice as far from first fork as from margin of wing; hind wings with two cross veins; all other characters as in apterous form.

Sexuales have not been taken.

Collections were all taken on *Cercocarpus parvifolius* in Larimer County in altitudes from 5000 to 8000 feet by L. C. Bragg, F. C. Hottes and the authors.

Apterous Viviparous Female.—Three collections, August 15 to 21.
Alate Viviparous Female.—One collection, August 21.

Types in collection of United States National Museum (Slides No. 41461); paratypes in collection of Colorado Agricultural Experiment Station.

Aphis lupini, n. sp.

Fundatrix.—Described from a single specimen taken on *Lupinus decumbens* at Fort Collins, Colorado, May 22, 1918, by L. C. Bragg.

Color: Entire dorsum dull blackish-green shading to black on head; antennæ, legs, cornicles and cauda black throughout.

*Altitude 8,000 feet.

Measurements: Body to base of cauda 3 mm. by 2 mm.; hind tibiæ 1 mm.; antennæ 1.20 mm.; joints as follows: III and IV anastomosed, .47 mm.; V, .23 mm.; VI, .15 mm. + .18 mm.; cornicles, .21 mm.; cauda, .26 mm.

Structural characters as in apterous viviparæ.

Although this specimen was taken rather late for a fundatrix and in company with evident summer generations, the shorter cornicles and antennæ and the five-jointed condition of the antennæ as well as the darker color of the individual make it seem almost certain to be a fundatrix.

Apterous Summer Viviparous Female.—(Plate V, Fig. 7; Plate VI, Figs. 15 and 19). Described from type taken on ***Lupinus decumbens*** at Boulder, Colorado, June 3, 1912, by L. C. Bragg, also 4 paratypes taken on same host, at Fort Collins, Colorado, May 13, 1916, by same collector.

Color: Entire dorsum dusky olive-green, shading to brownish on head; antennæ pale shading to blackish toward tip, especially on distal ends of joints; legs dusky to black throughout except proximal portions of femora; cornicles and cauda black. In cleared or alcoholic specimens dark bands appear on 7th and 8th abdominal segments.

Measurements: Body to base of cauda, 2.10 mm. (2 to 3 mm.) by 1.10 to 1.80 mm.; hind tibiæ, 1.10 mm.; antennæ 1.50 mm.; joints as follows: III, .38 (.36 to .40 mm.); IV, .33 mm. (.25 to .33 mm.); V, .25 mm.; VI, .14 mm. + .25 mm.; cornicles .25 mm.; cauda, .28 mm.

Structural characters: Secondary sensoria on antennæ lacking; hairs on body pointed, .03 mm. long, sparse and inconspicuous; similar on antennæ and legs but more numerous; on cauda curved, 6 or 7 on each side; cornicles rather closely imbricated, cylindrical or slightly larger at bases, flanges present but inconspicuous, frontal tubercles short but distinct; lateral and ocular tubercles present; cauda acute conical, with only slight constriction.

Alate Viviparous Female.—(Plate V, Fig. 8; Plate VI, Figs. 16, 17 and 18). Described from type and three paratypes taken on ***Lupinus*** sp. at Boulder, Colorado, June 3, 1912, by L. C. Bragg, and one other taken on same host at Fort Collins, Colorado, May 15, 1916, by the same collector.

Color: Head and thorax coal black; abdomen greenish-black, antennæ rather dusky throughout, except proximal portion of joint III; legs pale except femora, especially 2d and 3d pairs, which are dusky on distal portions, and tarsi and tips of tibiæ which are black; cornicles and cauda dusky; wing veins rather heavy and black, stigmas dusky-yellowish.

Measurements: Body to base of cauda 2.25 mm.; hind tibiæ 1.10 mm.; antennæ 1.50 mm., joints as follows: III, .37 mm. (.35 to .38 mm.); IV, .30 mm. (.25 to .30 mm.); V, .27 mm. (.22 to .27 mm.); VI, .15 mm. + .25 mm.; cornicles .20 mm. (.19 to .23 mm.); cauda .20 mm.

Structural characters: Secondary sensoria round and arranged in a row on posterior side of joint III, 4 in number (3 to 6), absent on remaining joints; fore wings with mediæ twice branched; hind wings with 2 cross veins; other characters as in apterous viviparæ.

Collections were all taken on *Lupinus decumbens* at Fort Collins, Boulder and Bellvue*, Colorado, by L. C. Bragg and F. C. Hottes.

Fundatrix.—One collection, May 22.
Apterous Viviparous Female.—Eleven collections, May 13 to August 31.
Alate Viviparous Female.—Four collections, May 15 to July 6.

This is a common species in northern Colorado.

Types in collection of the United States National Museum (Slides No. 41462); paratypes in collection of Colorado Agricultural Experiment Station.

Aphis ribiensis, n. sp.

Fundatrix.—(Plate V, Fig. 9; Plate VI, Fig. 20). Described from type taken on *Ribes longiflorum*, at Fort Collins, Colorado, May 26, 1909, by the senior author.

Color: Entire dorsum pale yellowish-green, becoming lighter on head; cornicles and cauda nearly colorless; antennæ colorless except distal two joints which are dusky to black; legs colorless except tarsi and distal ends of tibiæ which are blackish.

Measurements: Body to base of cauda, 1.90 mm. by 1.10 mm.; hind tibiæ .55 mm.; antennæ, .54 mm.; joints as follows: III, .18 mm.; IV, .09 mm.; V, .08 mm. + .10 mm.; cornicles .11 mm.; cauda .14 mm.

Structural characters: Apterous; antennæ five-jointed; all other characters as in apterous viviparæ.

Apterous Viviparous Female.—(Plate VI, Figs. 21 and 22). Described from type and 5 paratypes taken on *Ribes longiflorum*, at Fort Collins, Colorado, May 26, 1909, by L. C. Bragg.

Color same as in fundatrix.

Measurements: Body to base of cauda, 1.80 mm. by 1 mm.; hind tibiæ, .85 mm.; antennæ, .95 mm.; joints as follows: III, .24 mm.; IV, .16 mm.; V, .15 mm.; VI, .11 mm. + .13 mm.; cornicles .20 mm.; cauda .19 mm.

Structural characters: Secondary sensoria absent on antennæ; hairs on body pointed, .04 mm. long, very sparse and inconspicuous; on antennæ slightly more numerous; on tibiæ, .04 to .05 mm. long, rather numerous; on cauda, long curved, and 3 to 4 on a side; cornicles imbricated, cylindrical or slightly tapering in shape; cauda rather triangular with slight neck; frontal tubercles absent; lateral tubercles present; ocular tubercles present.

Pupa.—Abdomen yellowish-green; thorax much paler; head a little dusky; cornicles quite pale; wing pads black. Some individuals with very distinct mottling on dorsum as in pupæ of *A. gossypii.*

Alate Viviparous Female.—(Plate V, Fig. 10; Plate VI, Figs. 23, 24 and 25). Described from type and 6 paratypes taken on *Ribes longiflorum*, November 3, 1910, at Fort Collins, Colorado, by L. C. Bragg.

Color: Head and thorax black; abdomen yellowish-green; antennæ dusky, lighter on basal portion of joint III; legs pale ochre with tips black; cornicles and cauda pale; stigmas pale dusky-yellowish.

*In neighboring hills, altitude 8,000 feet.

Measurements: Body, to base of cauda, 1.65 mm.; hind tibiæ, .80 mm.; antennæ, .95 mm.; joints as follows: III, .26 mm.; IV, .15 mm.; V, .14 mm.; VI, .10 mm. + .22 mm.; cornicles .13 mm.; cauda, .17 mm.

Structural characters: Secondary sensoria on antennal joints rather large and round, arranged in irregular or partly double row on posterior side of joint III, 10 in number (9 to 12); IV, 5; hairs on body .02 mm. long, pointed fine, sparse and very inconspicuous; hairs on antennæ similar to those on body; hairs on legs .02 to .03 mm., pointed and moderately numerous; hairs on cauda .05 mm. long, curved and 3 or 4 on each side; cornicles imbricated, cylindrical and with flange; cauda aphis-like with constriction near base; frontal tubercles lacking; lateral tubercles present; ocular tubercles distinct; fore wings with mediæ twice branched, with second fork arising at a point two-thirds the distance from origin of first fork to margin of wing; hind wings with two cross veins.

Male.—(Plate V, Fig. 13; Plate VI, Figs. 26 and 27). Described from type and 6 paratypes taken November 2, 1910, and 8 paratypes taken October 26, 1910, all on *Ribes longiflorum* at Fort Collins, Colorado, by L. C. Bragg.

Color: Head and thorax black; abdomen dusky dark green; antennæ black or blackish throughout; legs pale ochre-yellow with same parts black as in alate viviparæ; cornicles and cauda dusky; stigmas greenish.

Measurements: Body, to base of cauda, 1.33 mm.; hind tibiæ, .65 mm.; antennæ, .85 mm.; joints as follows: III, .23 mm.; IV, .17 mm.; V, .15 mm.; VI, .10 mm. + .17 mm.; cornicles, .08 mm.; cauda, .10 mm.

Structural characters: Alate, secondary sensoria as follows: on III, 22; on IV, 15; on VI, 6 (5 to 12); other characters as in alate viviparæ.

Oviparous Female.—(Plate V, Fig. 11; Plate VI, Figs. 28, 29 and 30). Described from type and one paratype taken October 26, 1910, also two others taken November 2, 1910, all on *Ribes longiflorum* at Fort Collins, by L. C. Bragg.

Color: Entire dorsum pale yellowish to whitish; slightly brownish tinge on head; all appendages colorless or whitish, except tarsi, which are blackish, and tips of tibiæ which are slightly dusky.

Measurements: Body, to base of cauda, 1.55 mm.; hind tibiæ, .40 mm.; antennæ, .55 mm.; joints as follows: III, .17 mm.; IV, .09 mm.; V, .08 mm. + .11 mm.; cornicles .08 mm.; cauda, .11 mm.

Structural characters: Apterous; secondary sensoria absent on antennæ; sensoria on hind tibiæ rather large and somewhat tuberculate, scattered over proximal two-thirds which are slightly swollen; other characters as in fudnatrix; cauda sometimes rather broad as in Fig. 30a.

Egg.—(Plate V, Fig. 12) .55 mm. by .29 mm.; greenish yellow when first laid, turning to deep shining black later.

Collections were taken on *Ribes longiflorum* at Fort Collins, Colorado, by L. C. Bragg and the senior author. They are found on the tender shoots and terminal leaves which they cause to curl and form a sort of a rosette.

Fundatrix.—One collection, May 26.
Apterous Summer Viviparous Female.—One collection, May 26.
Alate Viviparous Female.—Six collections, May 31 to November 3.
Male.—Five collections, October 17 to November 2.
Oviparous Female.—Five collections, October 17 to November 2.

Types in collection of United States National Museum (Slides No. 41463); paratypes in collection of Colorado Agricultural Experiment Station.

This species occurs in same colonies with *Aphis varians* Patch (now *A. epilobii* Kittel (?)), but may be distinguished by the absence of sensoria on antennal joint IV of alatæ, by fewer hairs on cauda, 2 or 3 on a side in *ribiensis*, while *varians* has 6 on a side, also by difference in length of cornicles, .10 to .13 mm. in *ribiensis*, and about .20 mm. in *varians*. They differ also in color, *varians* being dark green while *ribiensis* is pale yellow-green.

Aphis asterensis, n. sp.

Apterous Summer Viviparous Female.—(Plate V, Fig. 14; Plate VIII, Figs. 1, 2 and 3). Described from type and 6 paratypes taken on *Aster multiflorus* taken at Fort Collins, Colorado, May 29, 1916, by L. C. Bragg, also two others taken May 8, 1916, with same data.

Color: Entire dorsum pale greenish-yellow, only tips of antennal joints III, IV and V, and entire joint VI, tarsi and tips of tibiæ dusky to black; cornicles pale with slight dusky shade distally; cauda pale.

Measurements: Body to base of cauda, 1.30 mm.; hind tibiæ, .60 mm.; antennæ, .75 mm.; joints as follows: III, .22 mm. (.17 to .26 mm.) IV, .10 mm.; V, .08 mm.; VI, .09 mm. + .17 mm. (.14 to .20 mm.); cornicles .11 mm. (.11 to .15 mm.); cauda, .14 mm.

Structural characters: Secondary sensoria on antennal joints rather large, round and arranged in a row on posterior side of joint, on III, 2 or 3, on distal half; on IV, 0 on one antenna and 1 on the other at tip of joint; hairs on body capitate, .03 to .05 mm. long, three pairs of rows on dorsum of abdomen becoming shorter anteriorly, very minute or absent on thorax; on antenna capitate, .01 mm., very sparse and inconspicuous; on tibiæ blunt, .01 to .05 mm. long, and fairly numerous; on cauda, 2 capitate hairs near tip, 2 curved, pointed hairs on each side; cornicles smooth, cylindrical, with rather broad flanges; cauda long, rather slender, irregular and approximately parallel sided distally, spreading at base; frontal tubercles lacking; lateral tubercles present, but difficult to observe in most of the specimens; ocular tubercles present.

Alate Viviparous Female.—(Plate V, Fig. 15; Plate VIII, Figs. 4, 5 and 6). Described from type taken on *Aster multiflorus* at Fort Collins, Colorado, May 9, 1916, by L. C. Bragg, also 4 paratypes taken May 29, 1916, with same data.

Color: Head and thorax yellowish-brown; abdomen light yellow mottled with pale green; antennæ dusky to black throughout; legs

pale with distal halves of femora slightly dusky, extreme tips of tibiæ blackish, entire tarsi black; cornicles slightly dusky, cauda pale, wing veins heavy and black; stigmas dusky-yellow.

Measurements: Body to base of cauda, 1.40 mm.; hind tibiæ, .70 mm.; antennæ, 1.10 mm.; joints as follows: III, .35 mm. (.33 to .40 mm.); IV, .15 mm.; V, .12 mm.; VI, .11 mm. + .23 mm.; cornicles, .14 mm. (.10 to .15 mm.); cauda, .14 mm.

Structural characters: Secondary sensoria on antennæ large, round and irregular in size, scattered along entire joint, on III, 10 (10 to 14) in number; on IV, 4 on one antenna and 6 on the other; on V, 0 on left side and 1 on the right; fore wings with mediæ twice branded, second fork varying considerably in size in hind wings with two cross veins.

Male.—(Plate VIII, Fig. 7). Described from type taken on *Aster multiflorus* at Fort Collins, Colorado, by L. C. Bragg.

Color: Not determined as specimen is mounted, but dusky markings appear in balsam to be the same as in alate viviparæ.

Measurements: Body to base of cauda, .80 mm. (?); hind tibiæ .55 mm.; antennæ, .83 mm.; joints as follows: III, .30 mm.; IV, .14 mm.; V, .10 mm.; VI, .07 mm. + .20 mm.; cornicles .05 mm.

Structural characters: Alate; secondary sensoria on antennæ round and rather tuberculate, on III, 22; on IV, 12; V, 4; all other characters as in alate viviparæ.

Oviparous Female.—(Plate VIII, Figs. 8, 9 and 10). Described from type and 12 paratypes taken with male above described.

Color: Not determined as specimens are mounted.

Measurements: Body to base of cauda, 1.40 mm.; hind tibiæ, .58 mm.; antennæ .75 mm.; joints as follows: III, .25 mm.; IV, .09 mm.; V, .10 mm.; VI, .09 mm. + .19 mm.; cornicles .11 mm. (.11 to .14 mm.); cauda, .15 mm.

Structural characters: Apterous; all characters as in apterous viviparæ except hind tibiæ, which are noticeably swollen on proximal one-third and bear large, flat, irregular sensoria, 11 (8 to 16) in number.

Collections were taken all on *Aster multiflorus* at Fort Collins, Colorado, by L. C. Bragg.

Apterous Viviparous Female.—Three collections, May 8 to October 5.
Alate Viviparous Female.—Two collections, May 8 to May 29.
Male.—One collection, October 5.
Oviparous Female.—One collection, October 5.

Types in collection of United States National Museum (Slides No. 41464); paratypes in collection of Colorado Agricultural Experiment Station.

Aphis pentstemonicola, n. sp.

Fundatrix.—(Plate VII, Fig. 1; Plate VIII, Figs. 11 and 12). Described from type and one paratype taken on *Pentstemon* sp. at Fort Collins, Colorado, April 23, 1919, by L. C. Bragg.

Color: Dorsum pale green, marked with dusky to black on head, dorso-lateral portions of pronotum, lateral areas of all segments, lateral spot on 6th abdominal segment extending mediad of cornicles, and

slight dorsal dashes on abdominal segments 7 and 8; antennæ dusky to black, except proximal portion of joint III, which is pale; legs pale dusky to colorless except tarsi and tips of femora and tibiæ which are black; cornicles and cauda black.

Measurements: Body to base of cauda, 1.73 mm.; hind tibiæ, .72 mm.; antennæ 1 mm.; joints as follows: III, .32 mm.; IV, .18 mm.; V, .14 mm.; VI, .12 mm. + .14 mm.; cornicles, .21 mm.; cauda .13 mm.

Structural characters: Apterous; secondary sensoria on antennæ round, moderately large, arranged in irregular double rows; on III, 10; IV, 4; joints III and IV anastomosed on paratype and one side of type; all other characters as in apterous viviparous female.

Apterous Summer Viviparous Female:—

Young, 1st instar.—(Plate VII, Fig. 2). Described from individuals born from fundatrices described above.

Color: Entire dorsum pale green, with a pair of large dusky areas on head; antennæ and legs pale grayish shading to darker at distal ends; cornicles and cauda dusky; young born from later generations showed dark green spot on dorsum of abdomen.

Adult.—(Plate VII, Fig. 4; Plate VIII, Figs. 13, 14 and 17). Described from type and one paratype taken June 7, 1915, also 2 paratypes, 2d generation, taken May 13, 1918, all on *Pentstemon* sp., and by L. C. Bragg.

Color: Head, pro- and mesothorax, a pair of dashes on metathorax, lateral areas of all abdominal segments, and broad dorsal bands on abdominal segments 6, 7 and 8, black; remainder of dorsum light yellow mottled with bluish or dusky-green; antennæ dusky to black, except extreme base of joint III, which is colorless; legs pale or colorless on proximal half to two-thirds of tibiæ, remaining parts dusky to black; cornicles and cauda black.

Measurements: Body, to base of cauda, 2 mm.; hind tibiæ 1. mm.; antennæ, 1.30 mm.; joints as follows: III, .36 mm. (.31 to .40 mm.); IV, .27 mm. (.21 to .29 mm.); V, .22 mm. (.17 to .29 mm.); VI, .13 mm. + .26 mm. (.18 to .27 mm.); cornicles .30 mm. (.30 to .38 mm.); cauda, .14 mm.

Structural characters: Secondary sensoria* on antennal joint III, 20 (18 to 30); IV, 12 (8 to 15); V, 8 (2 to 8); hairs on body fine, pointed and fairly numerous to sparse, .04 to .05 mm. in length; similar on antennæ but slightly shorter and more numerous; same on legs as on

*The number of secondary sensoria on antennæ in the apteræ seems to be a rather unstable character in this species. Frequently individuals were observed which bore fewer sensoria more confined to distal end of joint III than the typical forms, and this smaller number of sensoria appeared to be correlated with shorter antennal joints. In one extreme case taken on *Pentstemon* sp., at Boulder, Colo., August 15, 1912, by L. C. Bragg, a collection of 9 apterous specimens, numbers of secondary sensoria were as follows: III, 0 to 18; IV, 2 to 15; V, 0 to 9; lengths of antennal joints: III, .14 to .19 mm.; IV, .12 mm.; V, .10 to .12 mm.; VI, .08 mm. + .13 mm.; cornicles, .06 to .12 mm.; hind tibiæ, .40 to .50 mm. The bodies in this lot were much smaller than the typical forms, suggesting perhaps a stunting due to starvation. Considering the intergrading and mingling of variations in the same colonies, there does not seem to be justification at present for the determination of these as distinct species. Further biological study is needed to settle the question definitely.

antennæ; on cauda curved, .07 mm. long and three on each side; cornicles rather faintly imbricated, cylindrical or slightly tapering, flanges present; cauda short, rather conical, with a slight constriction at base; frontal tubercles lacking; lateral tubercles evident on pronotum, first, sixth and seventh segments of abdomen, inconspicuous or missing on other segments; ocular tubercles present.

Alate Viviparous Female.—(Plate H, Fig. 3; Plate J, Figs. 15, 16 and 18). Described from a second-generation individual taken May 28, 1915, 10 paratypes taken May 1, 1916, 7 taken May 13 and 14, 1918, and 12 taken June 4 and 8, 1917, all on *Pentstemon* sp. at Fort Collins, Colorado, by L. C. Bragg.

Color: Head, thorax, lateral areas on abdominal segments 1 to 5, area posterior and mediad to bases of cornicles, and slender dorsal dashes on abdominal segments 7 and 8 black; dorsum of abdomen pale green slightly mottled with darker green, cornicles and chitinized portion of cauda black; antennæ black except extreme base of joint III; legs pale sordid yellowish with dusky to black on distal portions of femora and tibiæ, and entire tarsi; stigmas sordid yellowish.

Measurements: Body to base of cauda, 1.80 mm.; hind tibiæ, .85 mm. (.75 to .90 mm.); antennæ, 1.20 mm.; joints as follows: III, .33 mm.; (.30 to .36 mm.); IV, .25 mm. (.20 to .25 mm.); V, .18 mm. (.17 to .20 mm.); VI, .12 mm. + .22 mm. (.17 to .24 mm.); cornicles, .20 mm. (.17 to .20 mm.); cauda, .12 mm.

Structural characters: Secondary sensoria* on antennæ round, convex, irregularly scattered over entire length of joints, on III, 36 (36 to 43); IV, 20 (15 to 20); V, 6 (5 to 9); hairs and tubercles as in apterous viviparous female; cornicles cylindrical, flanges present; cauda similar to that of apteræ but slightly more slender; fore wings with mediæ once forked; hind wings with 2 cross veins.

Male.—(Plate VII, Fig. 7; Plate VIII, Figs. 19, 20, 21). Described from type and 4 paratypes taken on *Pentstemon* sp. at Fort Collins, Colorado, October 19 and 20, 1916, by L. C. Bragg.

Color: Entire dorsum very dark olive-green; all appendages dark dusky-brown to black.

Measurements: Body, 1.10 mm.; hind tibiæ, .40 mm.; antennæ, .70 mm.; joints as follows: III, .16 mm. (.16 to .19 mm.); IV, .13 mm. (.12 to .16 mm.); V, .12 mm. (.10 to .13 mm.); VI, .07 mm. + .13 mm.; cornicles, .05 mm.; cauda, .06 mm.

Structural characters: Apterous; secondary sensoria on antennæ small, round and scattered, on III, 12 (9 to 18); IV, 11 (11 to 20); V, 6 (6 to 9); all other characters as in apterous viviparous female.

Oviparous Female.—(Plate VII, Fig. 6; Plate VIII, Figs. 22, 23 and 24). Described from type and 3 paratypes taken on *Pentstemon* sp. at Fort Collins, Colorado, October 20, 1916, by L. C. Bragg.

*A considerably smaller number of sensoria on antennal joint III was found in 4 individuals taken with apteræ mentioned in footnote for apterous viviparous form. Antennal joints were much shorter also. Numbers of sensoria are as follows: III, 20 to 24; IV, 12; V, 5 to 7. Lengths of joints: III, .20 to .24 mm.; IV, .14 mm.; V, .13 mm.; VI, .09 mm. + .19 mm.; cornicles, .08 mm.; hind tibiæ, .45 mm. The bodies were very small also. No other characters were observed which would warrant a determination as a distinct species.

Color: Dorsum brownish-yellow shading to dusky-brown on head, mottled with dusky-green on dorsum of abdomen; antennæ dusky-brownish, darker on terminal joints; legs sordid water-white, dusky to blackish on distal half of 2d and 3d pairs of femora, distal tips of tibiæ and entire tarsi; cornicles and cauda dusky.

Measurements: Body 1.40 mm.; hind tibiæ, .50 mm. (.40 to .50 mm.); antennæ .80 mm.; joints as follows: III, .17 mm. (.14 to .18 mm.); IV, .11 mm.; V, .11 mm. (.09 to .13 mm.) VI, .09 mm. + .14 mm. (.11 to .16 mm.); cornicles .07 mm.; cauda .10 mm.

Structural characters: Apterous, secondary sensoria on antennal joint III, 0; on IV, 1 or 2; hind tibiæ very slightly swollen on proximal two-thirds and bearing about 6 flat and very inconspicuous sensoria; all other characters as in apterous viviparous form.

Collections were taken on *Pentstemon* sp. in the vicinity of Fort Collins, Colorado, by L. C. Bragg.

Fundatrix.—One collection, April 23.
Apterous Viviparous Female.—Eleven collections, May 4 to October 20.
Alate Viviparous Female.—Fourteen collections, May 1 to October 20.
Male.—Two collections, October 19 and 20.
Oviparous Female.—Two collections, October 12 to 20.

Types in collection of United States National Museum (Slide No. 41465); paratypes in collection of Colorado Agricultural Experiment Station.

This species differs from *Aphis penstemonis* Will. (two cotype slides of which were examined), by the possession of sensoria on IV and V, IV and filament being subequal; cauda not so well constricted and more acute, and bearing only 3 hairs on each side. The sensoria are also more tuberculate.

The specimens on the cotype slides mentioned by J. J. Davis* as possessing sensoria on antennal joints IV and V were examined. They are certainly not males, but must belong to a distinct species. They appear to come close to our *Anuraphis pentstemonicola*, but show a distinctly smaller number of sensoria on joint IV.

Aphis phaceliæ, n. sp.

Fundatrix.—(Plate VII, Fig. 9; Plate VIII, Fig 25). Described from type and 2 paratypes taken on *Phacelia* sp. near Fort Collins, Colorado, April 15, 1919, by L. C. Bragg.

Color: Dorsum pale yellowish-green posteriorly shading anteriorly to pale green or apple-green mottled with darker bluish-green (Killarney green); cauda pale yellowish; legs pale yellowish except tarsi and tips of tibiæ which are black; antennæ pale except joint VI and distal portion of V; eyes and cornicles black.

*"Aphididæ of Nebraska," a Critical Review, p. 18.

Measurements: Body to base of cauda 1.76 mm.; hind tibiæ .70 mm.; antennæ .70 mm.; joints as follows: III, .30 mm. (.28 to .31 mm.); IV, .11 mm. (.08 to .11 mm.); V, .10 mm. + .12 mm.; cornicles .20 mm.; cauda .12 mm.

Structural characters: Apterous, antenna 5-jointed, without secondary sensoria; hairs short and sparse, as in summer apteræ, which it resembles in all other characters.

Apterous Summer Viviparous Female.—(Plate VIII, Figs. 26 and 28). Described from type and 4 paratypes taken on *Phacelia* sp., at Boulder, Colorado, June 1, 1911, also 2 paratypes taken near Bellvue, Colorado, September 22, 1915, all by L. C. Bragg.

Color of type specimen not observed before mounting in balsam. Paratypes taken September 22, 1915, (Plate VII, Fig. 10) were colored as follows: Dorsum, pale rusty-yellow on head, pale canary-yellow (pinard yellow) on thorax and abdomen, mottled with Killarney green on meso- and metathorax, and first three segments of abdomen; appendages of same color as in fundatrix.

Measurements: Body to base of cauda, 1.20 mm.; hind tibiæ .75 mm. (.66 to .75 mm.); antennæ 1 mm. (.83 to 1.00 mm.); joints as follows: III, .27 mm. (.20 to .27 mm.); IV, .19 mm. (.14 to .19 mm.); V, .15 mm.; VI, .10 mm. + .19 mm.; cornicles .28 mm. (.20 to .28 mm.); cauda .12 mm.

Structural caharacters: Secondary sensoria absent, hairs on body, antennæ and legs pointed, short, .02 to .03 mm. long, sparse, on cauda curved .07 or .08 mm. long, 3 on each side and one or two located dorsally; cornicles imbricated, cylindrical or somewhat tapering distally, with slight flanges; frontal tubercles lacking; lateral tubercles present on pronotum and abdominal segments 1 and 7; ocular tubercles present.

One example (Plate VIII, Fig. 27) taken in the same collection as the above bore 7 secondary sensoria on joint III of the antennæ; the cornicles measured .34 mm., and length of body to cauda 1.80 mm. In all other particulars it agreed with the type and certainly appeared to belong to the same species. The more frequent form, without secondary sensoria could not be considered immature as the shape of antennal joints and cauda were quite clearly that of the mature form.

Alate Viviparous Female.—(Plate VII, Fig. 8; Plate VIII, Figs. 29 and 30). Described from type and 18 paratypes taken on *Phacelia* sp., near Fort Collins, Colorado, by L. C. Bragg.

Color: Head, thorax, lateral spots on abdominal segments, especially a large patch posterior to cornicles, medial dashes on abdominal segments 6, 7 and 8, cornicles, tarsi, and tips of tibiæ black; distal one-half to two-thirds of second and third pairs of femora and entire antennæ dusky to blackish; abdomen pale apple-green marked with transverse dashes and median line of darker bluish-green, lighter on 6th segment; cauda and remainder of legs pale yellowish; stigmas dusky.

Measurements: Body to base of cauda 1.33 mm.; hind tibiæ .80 mm.; antennæ 1 mm.; joints as follows: III, .28 mm. (.23 to .28 mm.); IV, .17 mm. (.15 to .19 mm.); V, .14 mm. (.10 to .16 mm.); VI, .09 mm. + .19 mm.; (.19 to .23 mm.); cornicles .19 mm. (.15 to .20 mm.); cauda, .10 mm.

Structural characters: Secondary sensoria on antennal joint III, 8; on IV, 3 (1 to 3); fore wings with mediæ twice branched; hind wings with two cross veins; other characters as in apterous viviparæ.

Oviparous Female.—(Plate VII, Fig. 11). Described from type and one paratype taken on *Phacelia* sp. near Bellvue, Colordao, September 22, 1915, by L. C. Bragg.

Color: Entire dorsum amber-yellow, mottled with dusky-greenish from prothorax to cornicles, especially outlining eggs within the body; cauda yellowish; antennæ pale except joint VI and tip of V, which are dusky; cornicles, tarsi, and tips of tibiæ black; hind tibiæ brownish along entire length.

Measurements: Body to base of cauda 1.56 mm.; hind tibiæ .50 mm.; antennæ .83 mm.; joints as follows: III, .17 mm.; IV, .12 mm.; V, .11 mm.; VI, .09 mm. + .16 mm.; cornicles, .13 mm.

Structural characters: Apterous; characters same as in apterous viviparæ except hind tibiæ which are slightly swollen in proximal half. Sensoria could not be observed in these specimens as they were not sufficiently clear.

Collections were made on *Phacelia* sp. in north central Colorado, by L. C. Bragg.

Apterous Summer Viviparous Female.—One collection, June 1.
Apterous Sexupara.—One collection, September 22.
Alate Viviparous Female.—Four collections, May 16 to June 7.
Oviparous Female.—One collection, September 22.

Alate viviparæ were found to be quite numerous, while apterous viviparæ were very scarce.

Types in collection of United States National Museum (Slide No. 41466); paratypes in collection of Colorado Agricultural Experiment Station.

Braggia, n. gen.*

Characters: Antennæ short, about half the length of body; filament of antennal joint VI subequal with base of joint; cornicles conical with wide flanges; dorsum of apterous forms reticulated with white and heavily set with coarse blunt spines or plates; cauda semicircular.

This genus differs from *Anuraphis* Del Guercio by the character of the hairs and the shortness of the antennal filaments. These characters may seem to place it close to *Symydobius* Mordvilko, but the shape of the hairs in the apterous form and the presence of lateral tubercles and much shorter antennæ make it seem distinct.

Type: *Braggia echinata*, n. sp.

*The authors take great pleasure in naming this genus for the late Mr. L. C. Bragg, who first collected its type species, and who for several years was a most enthusiastic and efficient co-worker in the study of the aphid fauna of Colorado. In fact, it was through his efforts that a large proportion of the rather extensive collection of *Aphididæ* in the Colorado Agricultural Experiment Station was gathered together.

Braggia echinata, n. sp.

Apterous Summer Viviparous Female.—(Plate VII, Fig. 13; Plate VIII, Figs. 31, 32 and 33). Described from type and two paratypes taken on *Eriogonum* sp. at Fort Collins, Colorado, June 7, 1916, by L. C. Bragg.

Color: Entire dorsum grayish olive-green marked with a reticulation of raised white waxy secretion and bearing white hairs or spines which are heavy and blunt or slightly enlarged at tip, thus giving a frosted appearance; antennæ and legs pale yellowish except brownish to dusky on distal ends; cornicles greenish-yellow to brown with dark flanges; usually a slight rusty area at base of each cornicle.

Measurements: Body 1.87 mm.; hind tibiæ .55 mm.; antennæ .70 mm.; joints as follows: III, .21 mm.; IV, .12 mm.; V, .11 mm.; VI, .08 mm. + .07 mm.; cornicles .07 mm., but little longer than diameter at base; cuada .07 mm., broader than long.

Structural characters: Secondary sensoria on antennal joints small, round and arranged in a row on posterior side of joint; on III, 4 (2 to 6); IV, 2 (0 to 2); antennal joints coarsely imbricated; hairs on body .03 to .05 mm. long, heavy and blunt; on antennæ very short and sparse or absent; on legs, .02 mm. long and rather sparse; on cauda pointed and slightly curved, 3 lateral and 1 dorsal on each side; cornicles slightly imbricated, not reticulated; conical in shape with distinct neck and wide flange; cauda semicircular with tendency to end in a point, broader than long; frontal tubercles lacking; lateral tubercles present on prothorax and 1st and 7th abdominal segments; ocular tubercles present but small and inconspicuous.

Alate Viviparous Female.—(Plate VII, Fig. 12; Plate VIII, Fig. 34). Described from type and 2 paratypes taken June 9, 1916, also 6 paratypes taken October 12, 1916, all on *Eriogonum* sp. at Fort Collins, Colorado, by L. C. Bragg.

Color: Head and thorax brown to blackish; abdomen yellowish olive-green; cauda concolorous with body, antennæ dusky to blackish except base of joint III, legs pale yellowish with distal half of femora brownish, tarsi and tips of tibiæ black; cornicles yellow-brown; stigmas dusky yellow.

Measurements: Body 1.40 mm.; hind tibiæ .50 mm.; (.47 to .60 mm.); antennæ .75 mm.; joints as follows: III, .25 mm.; IV, .15 mm.; V, .15 mm.; VI, .09 mm. + .07 mm.; cornicles .07 mm.; cauda .05 mm., broader than long.

Structural characters: Secondary sensoria on antennæ round but slightly convex, arranged in irregular row on posterior side of joint, on III, 8 (8 to 12); IV, 3; hairs similar to those on apterous form but so small and sparse on body as not to be noticeable except on lateral portions of abdominal segments 7 and 8; cornicles, cauda and tubercles as in apteræ; fore wings with mediæ twice branched; hind wings with two cross veins.

Oviparous Female.—(Plate VII, Fig. 14; Plate VIII, Figs. 36 and 37). Described from type and 8 paratypes taken October 6 and 7, 1916, also 9 paratypes taken October 17, 1916, by L. C. Bragg.

Color: Entire dorsum dusky olive-brown tinged with pinkish or rusty laterally and posteriorly covered as in apterous viviparæ with white reticulations and heavy, blunt, white spines; antennæ and legs darker than in apterous viviparous form, with entire hind tibiæ blackish. Immature forms resemble the viviparæ in color.

Measurements: Body, 1.62 mm.; hind tibiæ .50 mm.; antennæ .60 mm.; joints as follows: III, .17 mm.; IV, .12 mm.; V, .12 mm.; VI, .08 mm. + .07 mm.; cornicles .05 mm.; cauda, .05 mm.

Structural caharacters: Apterous; secondary sensoria on antennæ as in apterous viviparæ or tending to be slightly fewer; hind tibiæ swollen for almost entire length and bearing rather large, flat sensoria scattered over four-fifths of length; other characters as in apterous viviparæ.

Male.—(Plate VII, Fig. 15; Plate VIII, Fig. 35). Described from type and 6 paratypes on slides with oviparæ described above.

Color: Pupæ with pink abdomen, greenish thorax and black wing pads. Adults with head and thorax dark brown to black; abdomen pinkish to dark rusty-brown; antennæ dusky to black, legs sordid with the tips black.

Measurements: Body, 1 mm. (1 to 1.40 mm.); hind tibiæ .55 mm.; antennæ, .80 mm.; joints as follows: III, .24 mm.; IV, .16 mm.; V, .15 mm.; VI, .10 mm. + .09 mm.; cornicles .04 mm.; cauda, .03 mm.

Structural characters: Alate, secondary sensoria on antennæ as follows: on III, 30; IV, 15; V, 13; VI, 0 to 3; all other characters as in alate viviparæ.

Collections were taken on *Eriogonum* sp. at Fort Collins, Colorado, by L. C. Bragg as follows:

Apterous Viviparous Female.—Five collections, June 7 to October 7.
Alate Viviparous Female.—Five collections, July 8 to October 17.
Male.—Four collections, October 6 to 17.
Oviparous Female.—Six collections, October 6 to 17.

Types in collection of United States National Museum (Slide No. 41468); paratypes in collection of Colorado Agricultural Experiment Station.

Lachnus medispinosus, nov. nom. is here proposed for *Lachnus similis* Gill. and Pal. (published in 1924 in Ann. Ent. Soc. of Am. XVII: 1, 23), the original name having been preoccupied by Van der Goot in 1917.

Myzus essigi, nov. nom. is here proposed for *Myzus aquilegiæ* Essig (pub. 1917, Univ. of Calif. Pub. Ent. I, 314). Essig's name used by Theobald in 1913 (Jo. Ec. Biol. VIII, 92, 24).

EXPLANATION OF PLATES.

Plate I.

Plocamaphis braggii, n. sp. 1, apterous summer viviparous ♀; 2, alate summer viviparous ♀; 3, ♂; 4, oviparous ♀.

Anuraphis ornata, n. sp. 5, alate summer viviparous ♀; 6, apterous summer viviparous ♀; 7, young.

Anuraphis chrysothamnicola, n. sp. 8, oviparous ♀; 9, ♂; 10, apterous summer viviparous ♀; 11, young; 12, alate summer viviparous ♀.

Plate II.

Plocamaphis braggii, n. sp. 1, antenna of apterous summer viviparous ♀; 2, cauda of same; 3, antenna of alate summer viviparous ♀; 4, cornicle of same; 5, antenna of oviparous ♀; 6, cornicle, and 7, hind tibia of same; 8, antenna of ♂.

Anuraphis chrysothamnicola, n. sp. 9, antenna of apterous summer viviparous ♀; 10, antenna of alate summer viviparous ♀; 11, cauda of apterous summer viviparous ♀; 12, cauda of alate summer viviparous ♀; 13, cornicle of apterous viviparous ♀; 14, cornicle of alate viviparous ♀; 15, antenna of oviparous ♀; 16, cornicle of same; 17, antenna of male; 18, cornicle of same; 19, hind tibia of oviparous ♀.

Anuraphis ornata, n. sp. 20, antenna of alate viviparous ♀; 21, cornicle, and 22, cauda of same; 23, antenna of apterous summer viviparous ♀; 24, cauda of same; 25, antenna of male; 26, antenna of oviparous ♀; 27, cornicle, and 28, hind tibia of same.

Plate III.

Anuraphis flocculosa, n. sp. 1, apterous summer viviparous ♀; 2, alate viviparous ♀.

Anuraphis senecioradicis, n. sp. 3, apterous summer viviparous ♀; 4, alate viviparous ♀.

Anuraphis debilicornis, n. sp. 5, oviparous ♀; 6, alate viviparous ♀.

Siphonatrophia gravida, Knowl. 7, fundatrix; 8, young (1st instar); 9, alate viviparous ♀; 10, oviparous ♀ (side view on leaves of host); 11, oviparous ♀ (dorsal view); 12, egg; 13, apterous ♂; 14, alate ♂.

Plate IV.

Anuraphis flocculosa, n. sp. I, antenna of apterous summer viviparous ♀; 2, antenna, 3, cauda, and 4, cornicle, of alate viviparous ♀; 5, cauda, and 6, cornicle of apterous summer viviparous ♀; 7, antenna of ♂; 8, antenna, and 9, hind tibia of oviparous ♀.

Anuraphis senecioradicis, n. sp. 10, antenna of alate viviparous ♀; 11, antenna, 12, cornicle, and 13, cauda, of apterous summer viviparous ♀; 14, cauda of alate viviparous ♀; 15, antenna of ♂; 16, antenna, and 17, hind tibia of oviparous ♀.

Anuraphis debilicornis, n. sp. 18, antenna, and 19, cornicle of alate viviparous ♀; 20, antenna, and 21, cornicle of apterous summer viviparous ♀; 22, antenna, and 23, cornicle of ♂; 24, antenna, 25, cornicle, and 26, hind tibia of oviparous ♀; 27, cauda of alate viviparous ♀.

Siphonatrophia gravida Knowl. 28, antenna of fundatrix; 29, antenna, 30, cornicle, and 31, cauda, of alate viviparous ♀; 32, antenna of apterous summer viviparous ♀; 33, antenna, and 34, hind tibia of oviparous ♀; 35, antenna of alate ♂.

PLATE V.

Anuraphis laciniariæ, n. sp. 1, alate viviparous ♀; 2, apterous summer viviparous ♀.

Aphis fraseræ, n. sp. 3, alate viviparous ♀; 4, apterous summer viviparous ♀.

Aphis cercocarpi, n. sp. 5, apterous summer viviparous ♀; 6, alate viviparous ♀.

Aphis lupini, n. sp. 7, apterous viviparous ♀; 8, alate viviparous ♀.

Aphis ribiensis, n. sp. 9, fundatrix; 10, alate viviparous ♀; 11, oviparous ♀; 12, freshly laid egg; 12a, egg a few days after being laid; 13, ♂.

Aphis asterensis, n. sp. 14, apterous summer viviparous ♀; 15, alate viviparous ♀.

PLATE VI.

Anuraphis laciniariæ, n. sp. 1, antenna, 1a, cornicle of apterous summer viviparous ♀; 2, antenna, 3, cauda, of alate viviparous ♀; 4, hind tibia of oviparous ♀.

Aphis fraseræ, n. sp. 5, antenna of typical form, 5a, antenna of less usual form, 6, cornicle, and 7, cauda of apterous summer viviparous ♀; 8, antenna, and 9, cornicle of alate viviparous ♀.

Aphis cercocarpi, n. sp. 10, antenna, and 11, cauda of apterous summer viviparous ♀; 12, antenna, and 13, cornicle of alate viviparous ♀; 14, cornicle of apterous summer viviparous ♀.

Aphis lupini, n. sp. 15, antenna of apterous summer viviparous ♀; 16, cauda, 17, antenna, and 18, cornicle of alate viviparous ♀; 19, cornicle of apterous summer viviparous ♀.

Aphis ribiensis, n. sp. 20, antenna of fundatrix; 21, antenna, and 22, cornicle of apterous summer viviparous ♀; 23, antenna, 24, cauda, and 25, cornicle of alate viviparous ♀; 26, antenna and 27, cornicle of ♂; 28, antenna, 29, hind tibia, and 30 and 30a, cauda of oviparous ♀.

PLATE VII.

Aphis pentstemonicola, n. sp. 1, fundatrix; 2, young born of fundatrix; 3, alate viviparous ♀; 4, apterous summer viviparous ♀; 5, young born of summer viviparous ♀; 6, oviparous ♀; 7, ♂.

Aphis phaceliæ, n. sp. 8, alate viviparous ♀; 9, fundatrix, 10, late apterous viviparous ♀; 11, oviparous ♀.

Braggia echinata, n. sp. 12, alate viviparous ♀; 13, apterous summer viviparous ♀; 14, oviparous ♀; 15, ♂.

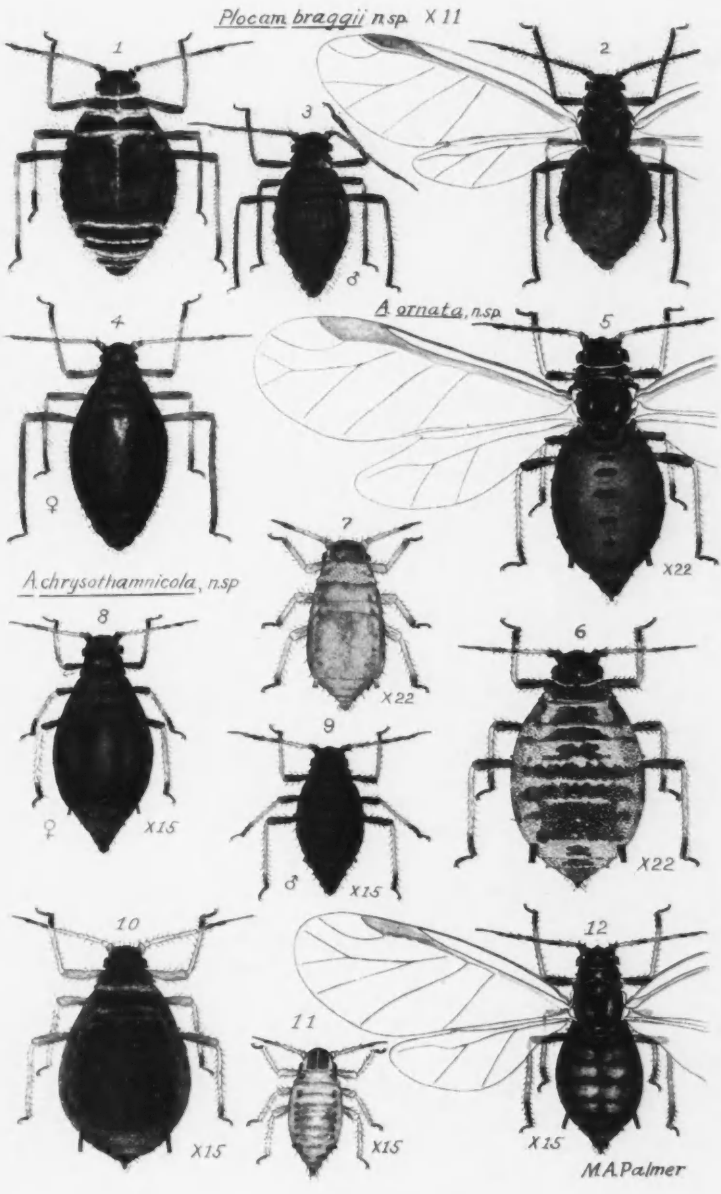
PLATE VIII.

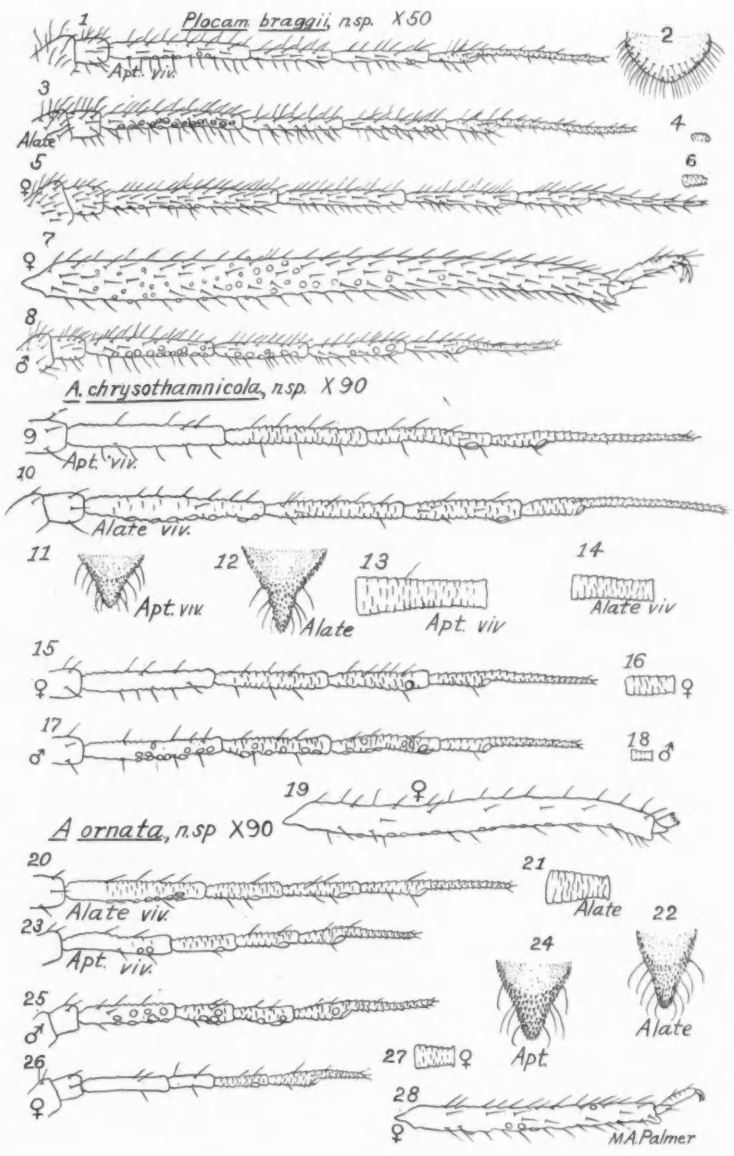
Aphis asterensis, n. sp. 1, antenna of apterous summer viviparous ♀; 2, cornicle, and 3, cauda of same; 4, alate viviparous ♀; 5, cornicle, and 6, cauda of same; 7, antenna of ♂; 8, antenna of oviparous ♀; 9, cornicle, and 10, hind tibia of same.

Aphis pentstemonicola, n. sp. 11, antenna of fundatrix; 12, cornicle of same; 13, antenna of apterous summer viviparous ♀; 14, cornicle of same; 15, antenna of alate viviparous ♀; 16, cornicle of same; 17, cauda of apterous summer viviparous ♀; 18, cauda of alate viviparous ♀; 19, antenna of ♂; 20, cornicle, and 21, cauda of same; 22, antenna of oviparous ♀; 23, cornicle, and 24, hind tibia of same.

Aphis phaceliæ, n. sp. 25, antenna of fundatrix; 26, antenna of typical, 27, antenna of atypical, and 28, cauda, of apterous summer viviparous ♀; 29, antenna, and 30, cornicle of alate viviparous ♀.

Braggia echinata, n. sp. 31, antenna, 32, cornicle, and 33, cauda of apterous summer viviparous ♀; 34, alate viviparous ♀; 35, antenna of ♂; 36, antenna, and 37, hind tibia of oviparous ♀.


Plocam. braggii n.sp. X 11
1
2
3
♂
4
♀
A. ornata, n.sp.
5
X22
A. chrysothamnicola, n.sp.
7
X22
8
♀
X15
9
♂
X15
6
X22
10
X15
11
X15
12
X15
M.A.Palmer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Alate
A. chrysothamnicola, n.sp. X90
Apt. viv.
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Alate
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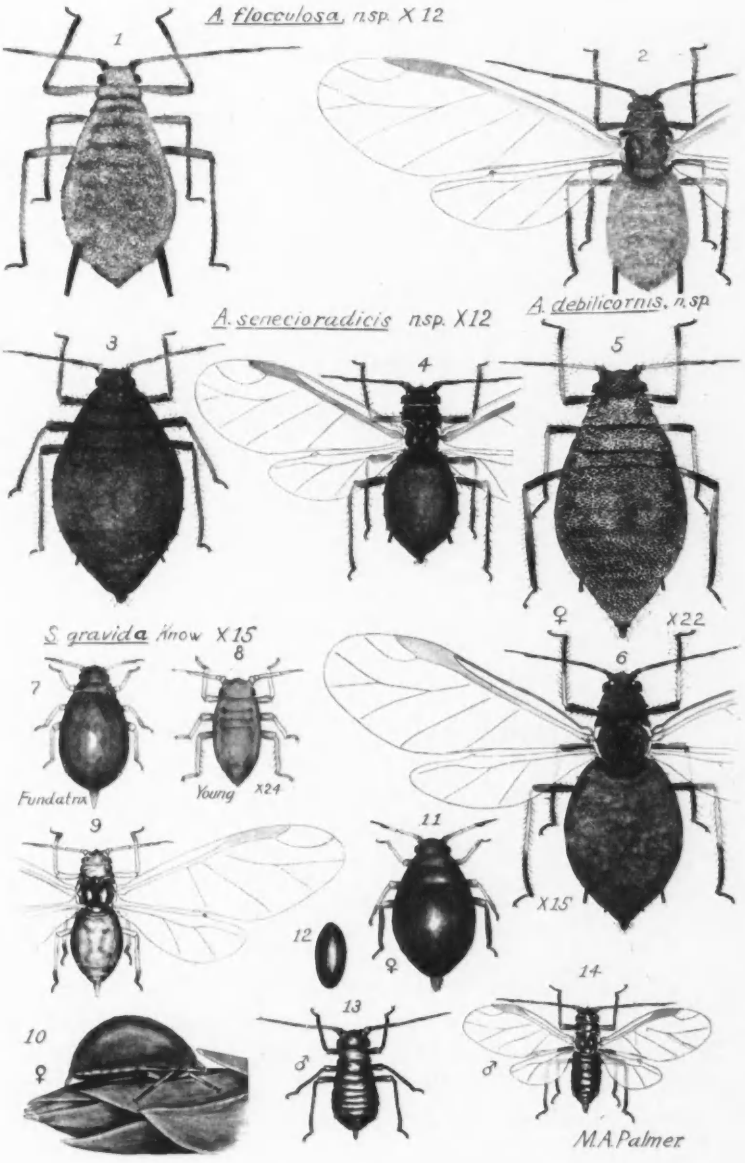
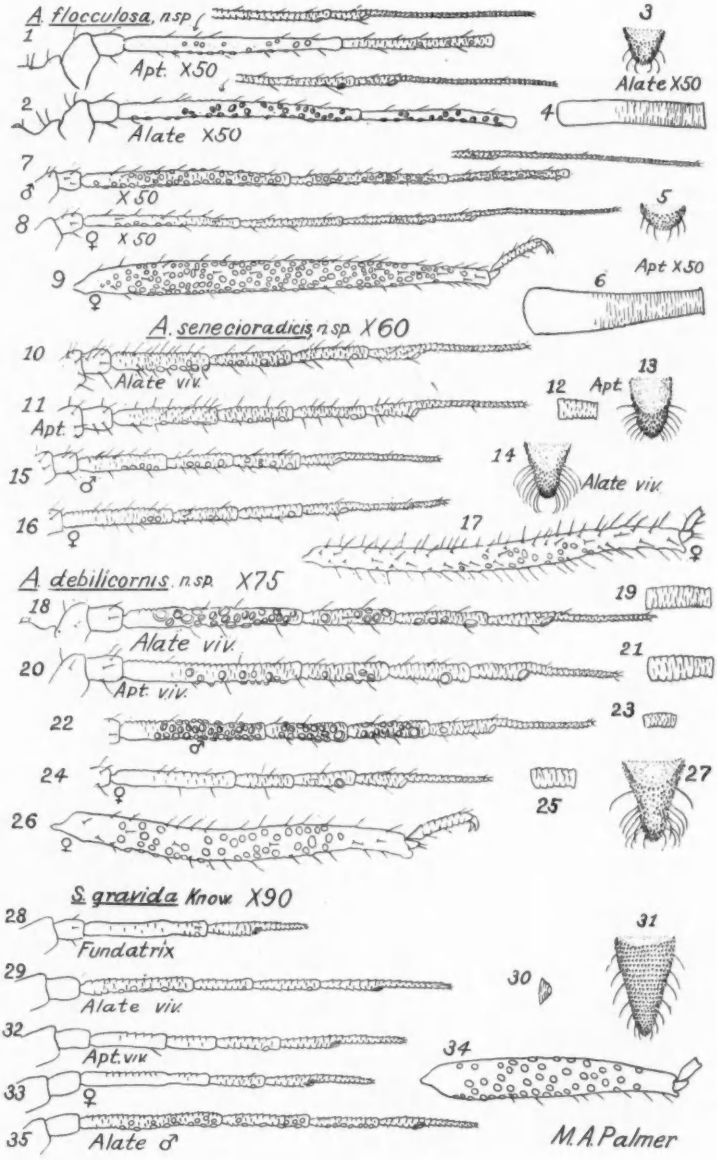
A ornata, n.sp X90
Alate viv.
Alate
Apt. viv.
Apt.
Alate
M.A. Palmer



Gillette and Palmer



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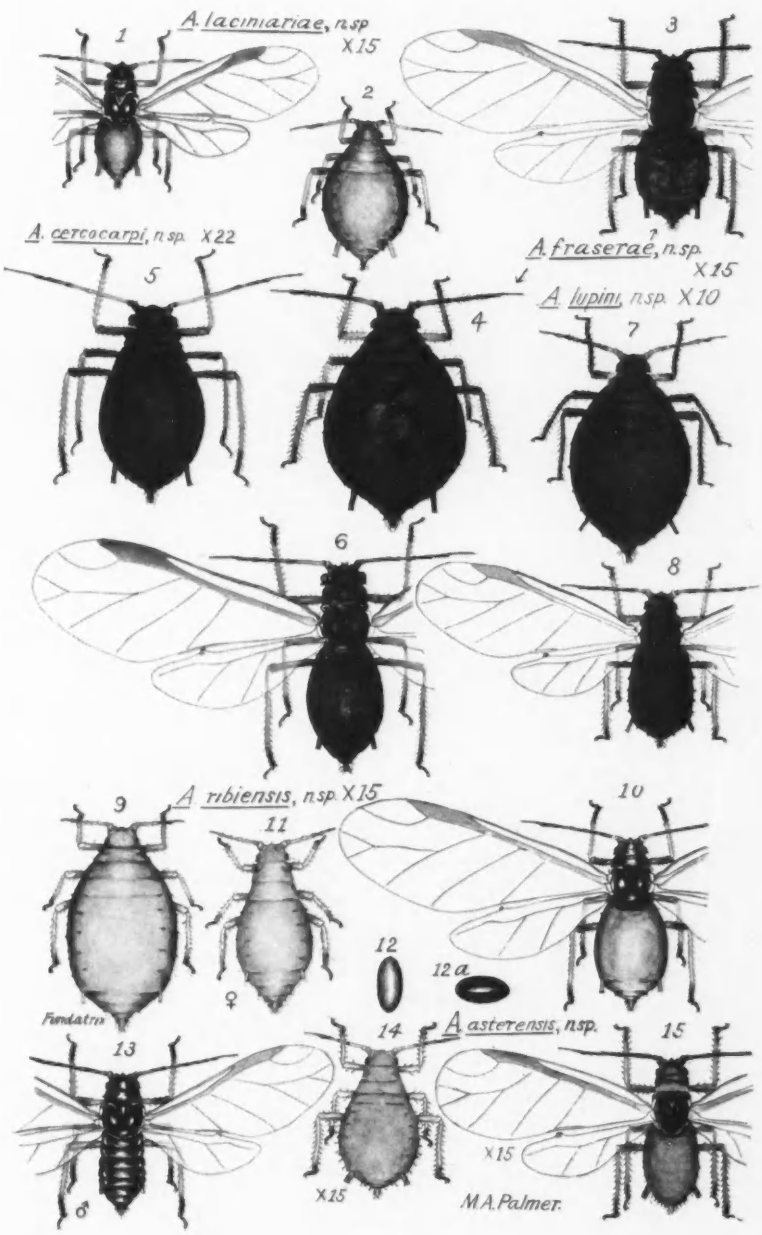

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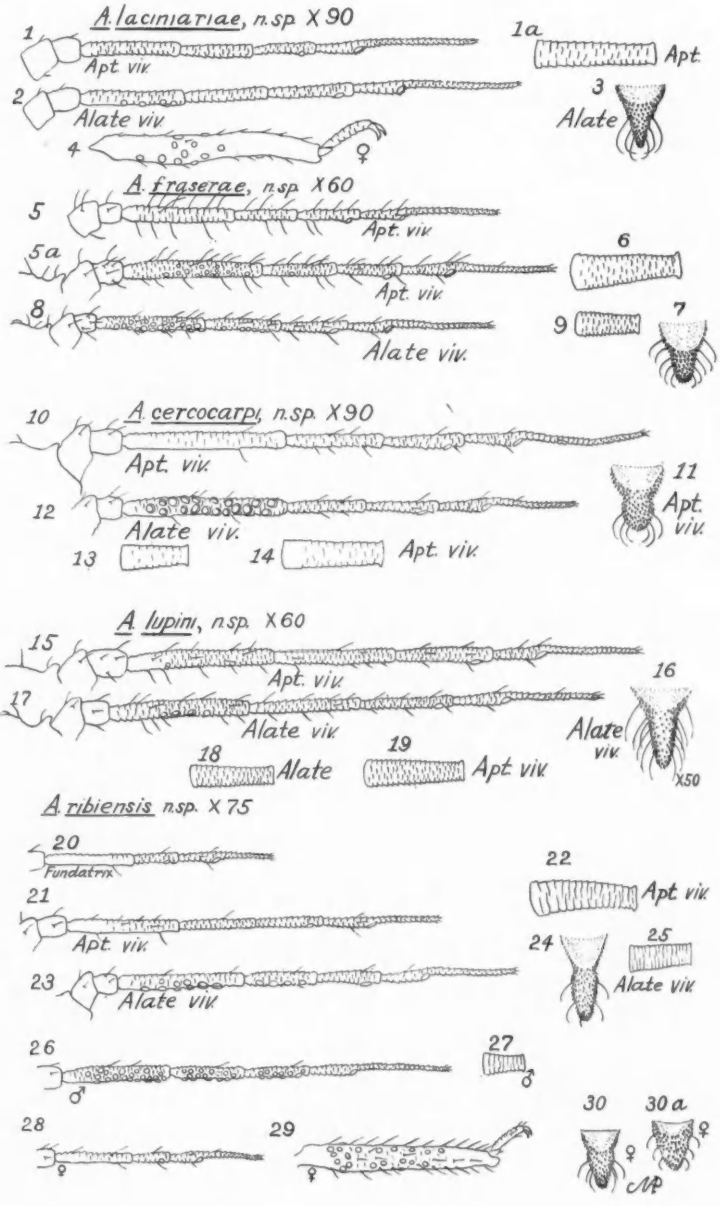

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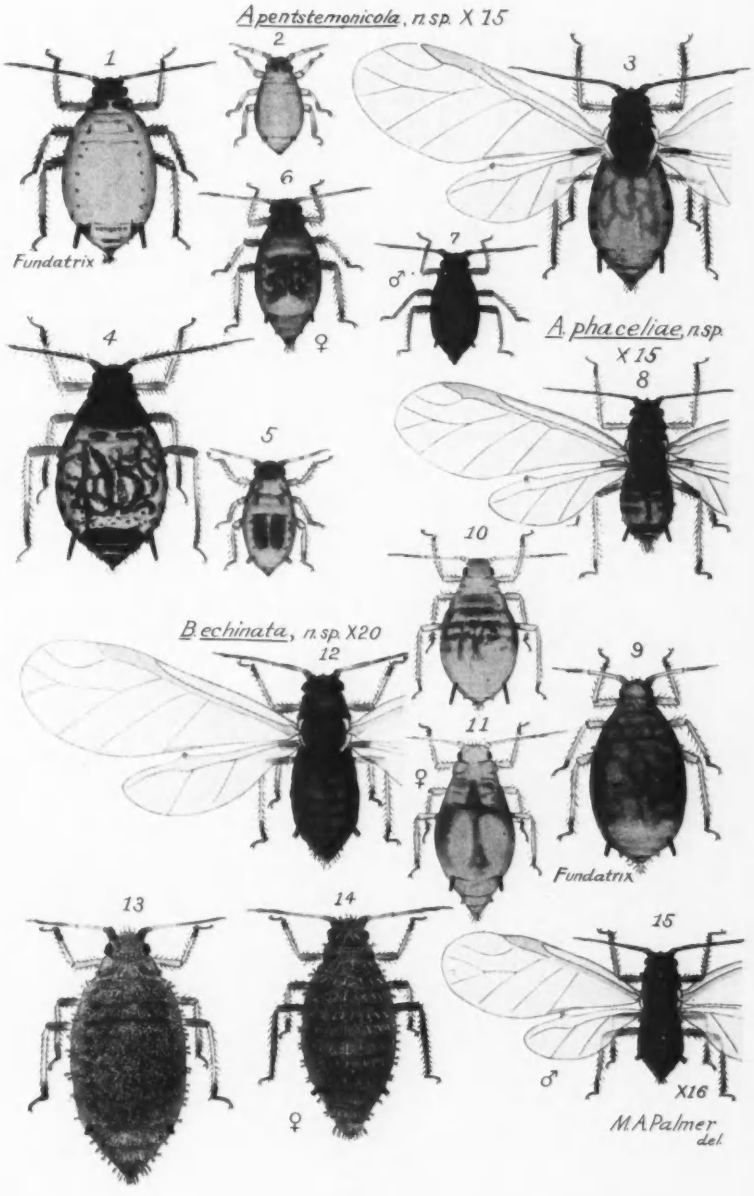

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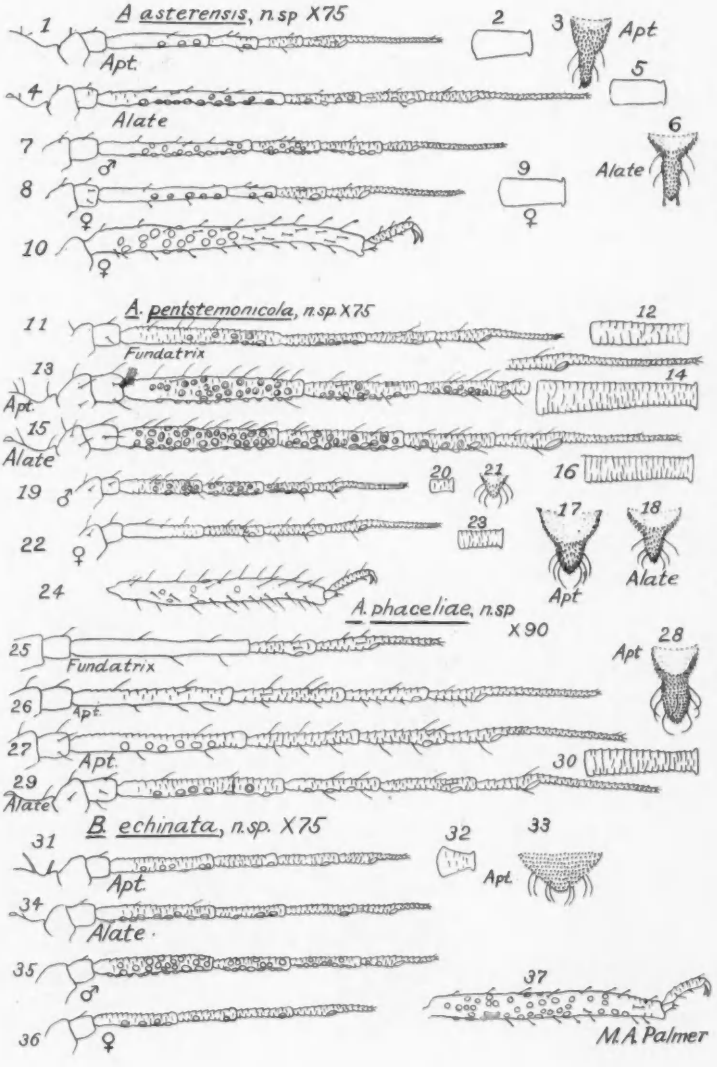
A asterensis, n.sp X75
1
Apt.
2
3
Apt
5
4
Alate
7
♂
8
♀
9
♀
6
Alate
10
♀
A. pentstemonicola, n.sp. X75
11
Fundatrix
12
13
Apt.
14
15
Alate
19
♂
20
21
16
22
♀
23
17
Apt
18
Alate
24
A. phaceliae, n.sp
X 90
25
Fundatrix
28
Apt
26
Apt.
27
Apt.
30
29
Alate
B. echinata, n.sp. X75
31
Apt.
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33
Apt.
34
Alate
35
♂
37
36
♀
M.A. Palmer

SOME NEOTROPICAL SCALE INSECTS ASSOCIATED WITH ANTS.*

(Hemiptera-Coccidæ).

By HAROLD MORRISON,
Bureau of Entomology, Washington, D. C.

Nearly all of the species of Coccidæ discussed in the following paper were received for study through Dr. W. M. Wheeler of Bussey Institution, Harvard University, and most of the material considered was collected by him in person in the Canal Zone and a few adjacent parts of the Republic of Panama. Others of the specimens discussed here were collected by Mr. James Zetek, of the Bureau of Entomology, located in the Canal Zone, who has, in the course of his work for the Bureau, collected a large series of specimens of scale insects, including many interesting forms in addition to those reported on here. The remaining specimens came from Vera Cruz, Mexico, Dutch and British Guiana and Trinidad. Studies on these specimens have naturally been materially aided by the availability of the large National Collection of Coccidæ, built up through many years of work on the part of the Bureau of Entomology of the United States Department of Agriculture, and the types of the new species described have been deposited in that collection.

The drawings illustrating the structural characters of the species described as new have been prepared by Miss Leola J. Kruger. The names of the ants involved, where given, have in each case been furnished by Dr. Wheeler.

Only two of the larger groups of the Coccidæ are represented in this material. They include the subfamily Coccinæ and a portion of the subfamily Dactylopinæ of the Fernald Catalogue for the first time formally restricted and elevated in rank as the subfamily Pseudococcinæ.

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* This paper was completed in March, 1924, and has not been revised prior to publication.

Subfamily PSEUDOCOCCINÆ.

The name Pseudococcinæ has been used previously by Brain (1, p. 79)†, and perhaps others, but apparently only as a substitute for the older name Dactylopiinæ. In its usage in this paper it is restricted to a group of genera, comprising a part of the old subfamily Dactylopiinæ, which are known to have at least one pair of dorsal ostioles, which, with very rare exceptions, have a small triangular and usually trilocular pore as the characteristic type and which have other, although often less tangible, morphological and habit characteristics. It is the writer's impression that this group has been recognized and definitely pointed out previously only by Professor Ferris (3, p. 30; 4, p. 60) who has definitely fixed its status by indicating most of the genera that can be properly included in it. The writer has for some time believed that this group of genera was entitled to subfamily standing in any system of classification which considers the scale insects as a family. Although reluctant to be the first to make use of the name in such a restricted sense in this rather incidental fashion, he has decided to employ it as indicated.

Genus **Pseudococcus** Westwood.

Pseudococcus brevipes Cockerell.

Cockerell (4, p. 308) has called attention to the fact that Bouché's use of the name *bromeliæ* in connection with the genus *Coccus*, was antedated many years by Kerner's publication of the same combination. An examination of Bouché's 1833 publication (2, p. 49), which the writer has finally been able to obtain, shows that the name "*Coccus bromeliæ*" was here used by Bouché and so verifies Cockerell's statement to the effect that this name is a homonym of *Coccus bromeliæ* Kerner, 1778.

It would seem, in consequence, that there is no alternative to accepting the next name which has been applied to the species, this apparently being *brevipes* Cockerell, 1893, which species, as the writer (9, p. 133) has stated, is identical with that which has in recent years been accepted as *bromeliæ* Bouché by all coccidologists. The erroneous citation of

† Numbers in parentheses refer to literature cited.

Bouché's original reference to this species as "*Lecanium bromeliæ*" in the Fernald Catalogue (7, p. 98) obscured the fact that a homonym had been established and that a change of name would be necessary.

With regard to the remainder of Professor Cockerell's conclusions on this subject, and dealing with the true identity of the *Coccus bromeliæ* of Bouché, the evidence of identity with the species now known as *Saissetia hemisphaerica* (Targ.) does not appear to the writer to be so conclusive as Professor Cockerell believes. A comparison of the orignal of Bouché's 1834 description (3, p. 20) of *Coccus bromeliæ* with what purports to be the same description translated into French, as given by Signoret in 1876, shows that the use of quotation marks has been rather abused by the translator. Thus, among other omissions and changes in the description of the female the following entire sentence, having an important bearing on the identity of this species, is omitted: "on the back of the animal are on each side two elevated cross bars—the boundaries between head, thorax and abdomen" (literal translation). This, in itself, certainly suggests *Saissetia oleae* rather than *S. hemisphaerica*, but the body color as given by Bouché (pale brown) suggests *hemisphaerica* or possibly early adult *oleae*.

The species *Lecanium bromeliæ* (Bouché), so far as the writer has been able to discover, dates from Burmeister's Handbuch der Entomologie, 1835, and was intended to be identical with Bouché's *Coccus bromeliæ*, and should be so considered.

The collections reported on herewith contain a number of lots of specimens which have been placed as *Pseudococcus brevipes* (Ckll.). In connection with the identification of these Panamanian mealybugs, the material from British Guiana previously published (9) has been reexamined, with the result that one lot, as noted in connection with the discussion of the new species immediately following, has been eliminated from those identified from British Guiana as *bromeliæ*. This elimination removes the only specimens from British Guiana having 6-segmented antennae and leaves all the specimens now included under *bromeliæ* with a range of antennal segmentation of from seven to eight instead of from six to eight.

The species of *brevipes* is represented by the following lots of material, collected by Dr. Wheeler in the Canal Zone: In

Cecropia, Salud, Rio Auga, March 6, with *Azteca* sp. (No. 120); in *Cordia alliodora* Rutz and Pavon, Red Tank, March 10, with *Azteca longiceps* Emery (No. 141); in *Triplaris cumingiana*, Las Cascadas, March 14, with *Azteca longiceps* (No. 167), with *Pseudomyrma christopherseni* Ford (No. 168), with *Azteca* sp. (No. 171); and in the same host, Miraflores, March 17, with *Crematogaster* sp. (No. 178, 181).

Pseudococcus maritimus (Ehrh.).

The collection contains a single specimen of a mealybug which it has not been possible to differentiate from presumably typical California specimens of this species. This adds another record to the constantly widening known distribution of this insect. The specimen was collected by Dr. Wheeler in *Cordia alliodora*, at Red Tank, Canal Zone, April 10, unattended by ants (No. 333).

Pseudococcus probrevipes, new species.

So far as known definitely, occurring only within swellings (myrmecodomatia) of the host twigs, attended by ants.

Adult female.—Described from alcoholic material only, so nothing regarding external appearance and secretion can be stated; very similar to ***brevipes***, (***bromeliæ*** of authors), differing principally in comparative characters; antennæ normally 7-segmented, rarely 6-segmented, in contrast to the eight segments normally, but by no means always, found in ***brevipes;*** ventral chitinous thickening of anal lobes relatively quite elongate and narrow as compared with the normally irregularly quadrate thickening of ***brevipes***, this character varying quite considerably in both species; with a loose band or cluster of setæ of only moderate length (about 14μ) immediately anterior to the anal ring dorsally, in contrast to the presence of a cluster of long slender setæ (about 35μ) in ***brevipes***, this character the most tangible differentiating one found thus far; antennal segments showing the following range of lengths, the measurements given in microns: I, 43-53; II, 36-43; III, 36-40; IV, 22-43; V, 18-28; VI, 29-35; VII, 66-80; legs stout, hind tibiae and femora with numerous small pores; number of spines in cerarii varying considerably, but about as follows: I (anterior), 3-4; II, 2-4; III, 2-3; IV, 2; V, 2; VI, 3; VII, 2-3; VIII, 1-3; IX, 2-3; X, 2; XI, 2-3; XII, 2; XIII, 2-4; XIV, 2-3; XV, 2-4; XVI, 3; XVII, 2; one lot of material (Wheeler No. 62) with the spines averaging distinctly more numerous, as follows from anterior to posterior: 4-6, 3-6, 2-3, 2-3, 3-4, 2-3, 2-4, 2-3, 2-3, 2-5, 2-5, 2-3, 2-6, 2-5, 3-7, 3-6, 2; accessory setæ of cerarii tending to stoutness, some almost spine-like in contrast to those of ***brevipes***, but this apparently variable.

This species has been characterized from one or more specimens from the following lots of material obtained by Dr. Wheeler in the Canal Zone: In *Cordia alliodora*, Frijoles, March 28, with *Azteca longiceps* (No. 232) (holotype and paratypes); Ancon, March 5, with *Pseudomyrma sericea* (No. 110); Red Tank, March 10, (No. 150); Quebrada de Ore, March 13, with *Crematogaster* sp. (No. 159); Las Cascadas, March 14, with

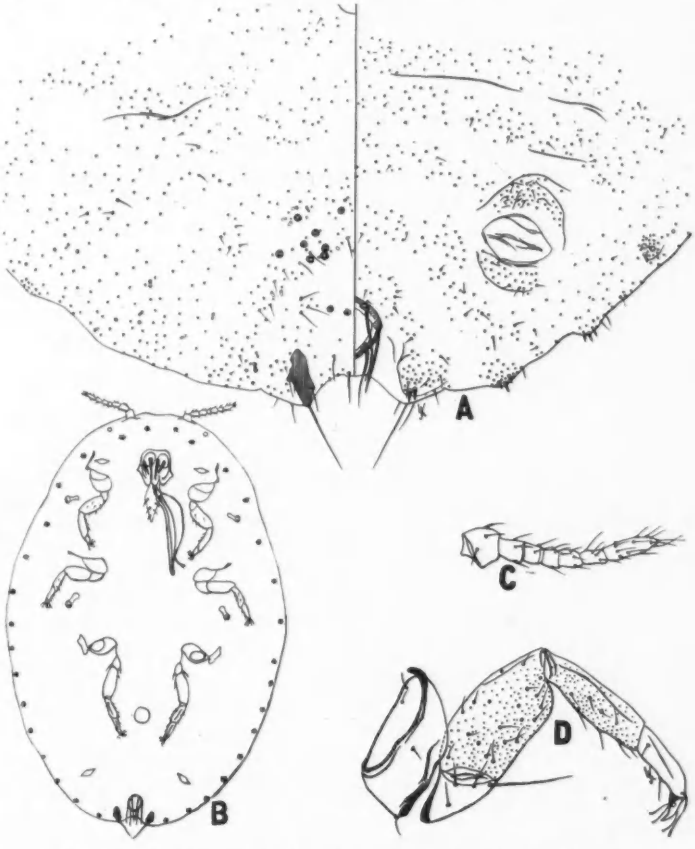

FIG. 1. *Pseudococcus probrevipes*, new species, all adult female.
A, apex of abdomen, showing pores, setæ, cerarii, anal ring, thickening, ostiole, dorsal to right, × 120; B, outline of body, optical section, showing parts, × 30; C, antenna, × 120; D, posterior leg, showing pores, × 120.

Azteca sp. (No. 166); Barro Colorado Id., March 20, with *Azteca longiceps* (No. 201 and 207); in *Triplaris cumingiana*, Ft. Clayton, February 28, with *Azteca* sp. (No. 62); Balboa, C. Z., March 26, with *Azteca* sp. (No. 225) and *Pseudomyrma christopherseni* (No. 226) (all paratypes). This species was also collected by Dr. Wheeler in several localities as indicated by these records: In *Cordia alliodora*, Barro Colorado Id, June 27, (No. 585), and July 21, (No. 730); Agua Clara Reservoir, Ft. Davis, C. Z., July 5, (No. 607); Gamboa, July 9, (No. 642); Corozal, July 12, (No. 666); Ancon, August 6, (No. 847). After reexamining the specimens recently reported on from the British Guiana (9, p. 133), the writer is of the opinion that one lot of these, that collected in *Cordia* with *Allomerus 8-articulatus* at Kartabo, July-August 1920, should be associated with the species characterized above rather than with *brevipes*.

Pseudococcus rotundus Morrison.

A single lot of material from the general type locality has been examined. These specimens, which appear to be entirely typical of the species, were collected in *Cecropia peltata* at Blairmont, British Guiana, with *Azteca alfari* var., on February 19, 1924, by H. E. Box.

Pseudococcus texensis Tinsley.

A comparison with the types shows that material collected in thorns of *Acacia veracruzensis* at Vera Cruz, Mexico, in 1924 by Dr. A. Dampf, is this species, which was originally described from an *Acacia*. Dr. Wheeler states that two species of ants, *Crematogaster corvina* (Mayr) and *C.* (*Orthrocrema*) *atra* Mayr, inhabited the interior of the *Acacia* thorns.

Genus **Farinococcus** Morrison.

Farinococcus multispinosus Morrison.

This species is represented by a few specimens collected in hollow branches of *Triplaris surinamensis* at Blairmont, British Guiana, with *Pseudomyrma triplaridis* Forel. sub sp. *boxi*, n. sub sp. Wheeler, on February 14, 1924, by H. E. Box. These specimens are dry and enough of the waxy secretion remains attached to them to indicate that they are probably rather heavily coated in life and have a heavy, continuous marginal band of white waxy secretion.

Subfamily COCCINÆ.

Genus **Coccus** Linnæus.

Coccus elongatus (Sign.).

A single specimen of this species, collected by Dr. Wheeler in spines of *Acacia penonomensis* Safford, Pueblo Nuevo, Panama, with *Pseudomyrma gracilis* (No. 271) is included in the collection.

Coccus hesperidum L.

Specimens, apparently this species, although considerably smaller than typical individuals and abnormal in shape, were obtained by Dr. Wheeler on leaves of *Cordia allivodora* at Ancon, Canal Zone, attended by *Azteca* sp. April 9, 1923 (No. 311).

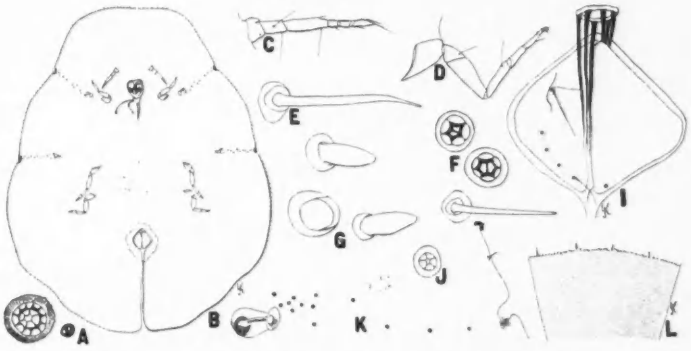

FIG. 2. *Mesolecanium inquilinum*, new species, all adult female.

A, dorsal pores, × 1000; B, body outline, optical section, showing parts and few dorsal pores, × 18; C, antenna, × 80; D, leg, × 80; E, marginal spine, × 1000; F, ventral abdominal disk pores, × 1000; G, spiracular spines, × 1000; H, dorsal seta, × 1000; I, anal plates, ventral to left, × 153; J, spiracular disk pore, × 1000; K, spiracles to margin, × 80; L, margin showing derm areolations, × 40.

Genus **Mesolecanium** Cockerell.

The described Central American species of this genus, including those from Mexico and that considered below, appear to form a compact group of species whose separation is difficult, if not impossible, on the basis of the material at present available for study. The status of the new species described herewith is therefore somewhat uncertain.

Mesolecanium inquilinum new species.

Living on the host bark within ant cartons.

Adult female.—Very closely resembling the genotype *M. nocturnum* (Ckll. and Parr.), apparently differing only in having noticeably fewer dorsal, compound, circular, disk-like pores anterior to the anal ring, in having the lateral spiracular spines shorter and stouter than in the enotype and in having the sub-marginal areolations, in general, smaller and more irregular in shape. Various details of the structure are shown in Figure 2.

This species has been described from three mounted specimens collected on an unknown host in tents of *Azteca*, Las Cascadus Cacao Plantation, Canal Zone, March 14, 1923, by W. M. Wheeler and J. Zetek (Z-1887).

Genus **Neolecanium** Parrott.

The two species described below and assigned to this genus cannot be considered as characteristic or typical and will probably be assigned to a hitherto unrecognized genus when the subfamily is given a critical revision.

Neolecanium craspeditæ, new species.

Occurring on the limbs and branches of the hosts, normally within ant cartons.

Adult female.—Maximum length about 2.5 mm., width about 2 mm., height about 1.5 mm., hemispherical, but most specimens smaller and very much flatter than this, the early adults having the disk completely depressed and less prominent than the heavily chitinized, strongly protruding marginal rim; color bright reddish brown, the centrally located anal plates a little more reddish, the marginal rims much darker, sometimes piceous, early adult female covered with a thin film of whitish, easily detached wax, the surface of this sometimes faintly nodulose but without traces of this wax in the fully developed female; surface of body of early adult faintly shining, that of mature adult highly polished; maximum length and width of body as mounted on slide slightly more than dimensions given above; derm clearing completely or, at most, in only a narrow band between disk and rim, depending on state of development; marginal rim and anal plates always more heavily chitinized than the remainder of body; derm with a rather conspicuous cluster of scattered disks on each side of the anal plates, and with numerous, but isolated, small, short tubular ducts distributed rather uniformly over most of the dorsal surface; antennæ somewhat reduced, normally 6-segmented, dimensions somewhat variable, measurements of one in microns as follows: I, about 15; II, 18; III, 45; IV, 10;

V, 9; VI, 18; legs likewise somewhat reduced, appear as shown in figure, trochanter obscured, tibia and tarsus fused, both pairs of digitules distinctly developed; spiracles not unusual, set well in from the body margin, in general resembling those of *Coccus*, joined to margin by a

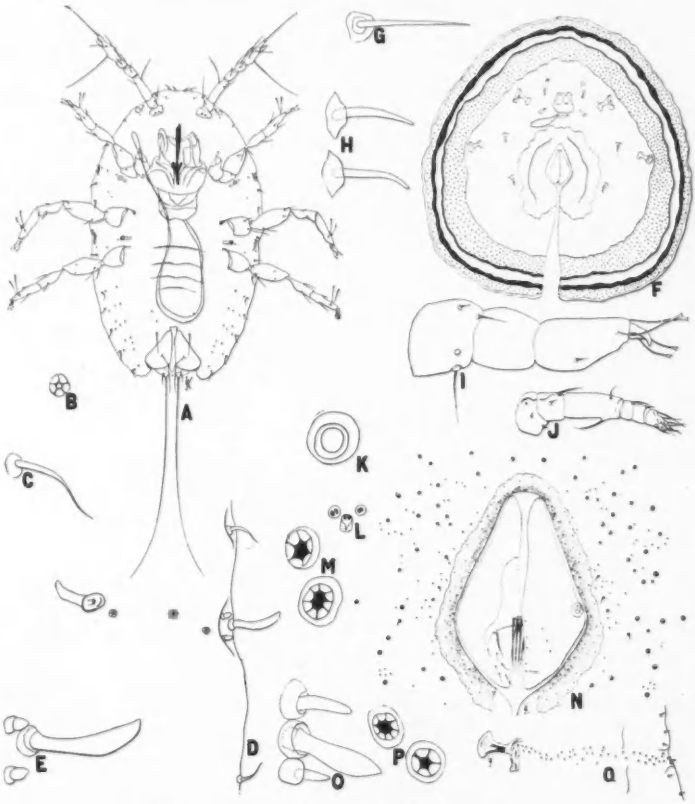

FIG. 3. *Neolecanium craspeditæ*, new species.

A, larva, outline from below, × 153; B, same, spiracular quinquelocular disk pore, × 1000; C, same, marginal seta, × 1000; D, same, spiracular region at margin, × 433; E, same, spiracular spines, × 1000; F, adult female, outline, optical section, of early adult, showing location of parts and partial chitinization, × 20; G, same, dorsal seta, × 1000; H, same, marginal seta, × 1000; I, same, leg, × 353; J, same, antenna, × 153; K, same, dorsal pore near anal plate, × 1000; L, same, minute bilocular dorsal pores, × 1000; M, same, ventral disk pores from anal plate region, × 1000; N, same, anal plates, ventral to left, × 80; O, same, spiracular spines, × 1000; P, same, spiracular quinquelocular disk pores, × 1000; Q, same, ventral region between spiracles and margin, × 80.

more or less distinct groove or depression and a row of scattered disk pores; marginal spines straight or somewhat curved, slender, bluntly pointed at apices, set in stout basal collar, average length about 10μ, spaced somewhat irregularly, but mostly three or more times the spine length apart; also with a submarginal row of more slender setæ; spiracular spines grouped in threes, all small and fairly stout, the median about 10μ long, the laterals about 6μ long, but all varying somewhat; dorsal surface with a few small slender setæ about 7-8μ long, these more numerous near anal plates; ventral surface with similar but more numerous and usually more slender setæ, varying in length and size; dorsal pores including the more or less conspicuous clusters of scattered disk pores on each side of the anal plates and the nearly uniformly distributed small tubular ducts; ventral pores including quinquelocular disk pores in rows between spiracles and margin, and larger, multilocular disk pores, with the number of loculi varying from 6 to 9, beneath the anal plates; anal plates elongate triangular in outline, the caudo-lateral margin much shorter than the anterio-lateral, length of one about 270μ, width about 80μ, with a distinct cicatrix at outer corner of each, with perhaps 20 tiny pores, normally bearing slender setæ scattered along the inner half of each plate, with as many as 10 similar seta-bearing pores along the caudo-lateral margin to apex, with 6 ventral ridge setæ arranged in pairs, with a single large fringe seta on each side and with a submedian pair of much smaller setæ on the edge of the fold; anal ring small, with pores and six setæ.

Larva.—As mounted, uniformly oval, length about 400 to 500μ, width about 280 to 330μ; antennæ 6-segmented, total length about 180 to 190μ, apical segment longest, third almost as long, apical seta about 80μ long; legs normal, total length about 220μ, claw with denticle, claw digitules slender, slightly knobbed, exceeding claw, one tarsal digitule inserted near tip, the other, distinctly larger and stouter, a little beyond middle of tarsus, the tips of both reaching about the same point beyond the claw as do the claw digitules; spiracles joined to spiracular spines by a row of 3 or 4 quinquelocular disk pores; marginal setæ slender, more or less distinctly angularly curved, about 14μ long, spiracular spines stout, the median about 18μ long, more or less distinctly swollen at apex, the laterals globular or stout oval, about 3μ long; with two submarginal rows of small setæ on each side and a single row of tiny pores between these; anal plates about 70μ long and 35μ wide, triangular, with an apical seta about 355μ long, two smaller setæ immediately adjacent to each apical seta, a larger preapical seta and one fringe seta; anal ring with pores and 6 setæ.

This species has been described from several mounted and unmounted specimens collected close to La Brea, Trinidad, beneath ant cartons on "Bois le-le" (*Cordia* sp.) by Harold Morrison on October 18, 1918 (A-803) and by C. B. Williams on November 4, 1918 (A-1025), (paratypes), and at Rio Agua Salud, Canal Zone, on Mango, in sheds of *Azteca trigona* by

W. M. Wheeler and James Zetek, March 6, 1923 (Z-1873), (holotype and paratypes).

The types are in the U. S. National Collection of Coccidæ.

The specimens from the Canal Zone differ from those from Trinidad in having a larger average size but other, presumably diagnostic, characters agree remarkably considering the distance and other barriers separating the two collection points.

Neolecanium derameliæ, new species.

Occurring on the bark of the host, beneath ant cartons.

Adult female.—Average length about 2 mm., width about 1.75 mm., height about 1 mm. (maximum); body color, in alcoholic specimens, pale yellow to reddish brown, the small, slightly elevated mid-dorsal area bearing the anal plates somewhat darker; body normally completely covered, except for anal plates, with a thin film of whitish glassy secretion, this transparent in alcohol; body usually showing an indistinct flattened marginal area; derm, after clearing with caustic potash, showing numerous, faintly chitinized streaks and spots and, usually, around the pore and seta bases, circles of chitinized derm, but heavily chitinized only in the region surrounding the anal plates, and, to a lesser extent, along the body margin; the peculiar and outstanding feature of the dorsal derm numerous, but scattered, spear-shaped spines having a cylindrical basal portion and slender lanceolate head occupying the apical third to one half of the length; antennæ much reduced, obscurely 5-segmented, average length about 56μ, with one or more setæ on each segment and spines at apex; legs even more reduced, indistinctly 2-segmented, claw short and stout, total length about 43μ, both claw and tarsal digitules present, those of claw rather stout and knobbed, those of tarsus more slender and blunt-tipped; spiracles of normal coccine type, set well in from the body margin and with a row of widely scattered quadri- to quinquelocular disk pores between each and its marginal spiracular spines; beak very short, stout-conical, apparently 1-segmented; marginal setæ slender, tapering, about 15μ long; spiracular spines fairly stout, bluntly rounded at apices, present in threes, the median about 18μ long, the laterals around 13μ, but all varying; peculiar dorsal setæ already described about 25μ long; with some slender ventral setæ beneath and behind anal plates; dorsally with a cluster of circular disks anterior to anal plates and with minute bilocular pores scattered widely over the whole dorsal surface; ventral disk pores in spiracular region already described, those beneath anal plates larger, with 7 to 9 loculi; anal plates placed at the approximate center of the body, the cleft large and wide, each plate large, elongate, slender, triangular, but with the anterio-lateral margin much longer than the posterio-lateral margin, with a distinct cicatrix at outer angle, average length about 280μ, width 85μ, each with three dorsal subapical, an apical, three or, rarely, four ventral ridge and one fringe setæ, all

long and slender, and the fold with about five hypopygial setæ; anal ring small, with 10 setæ with two pairs distinctly smaller than the others.

Larva.—Broad oval, length 465μ, width 328μ; antennæ 6-segmented, the measurements of one in microns as follows: I, 15; II, 15; III, 53;

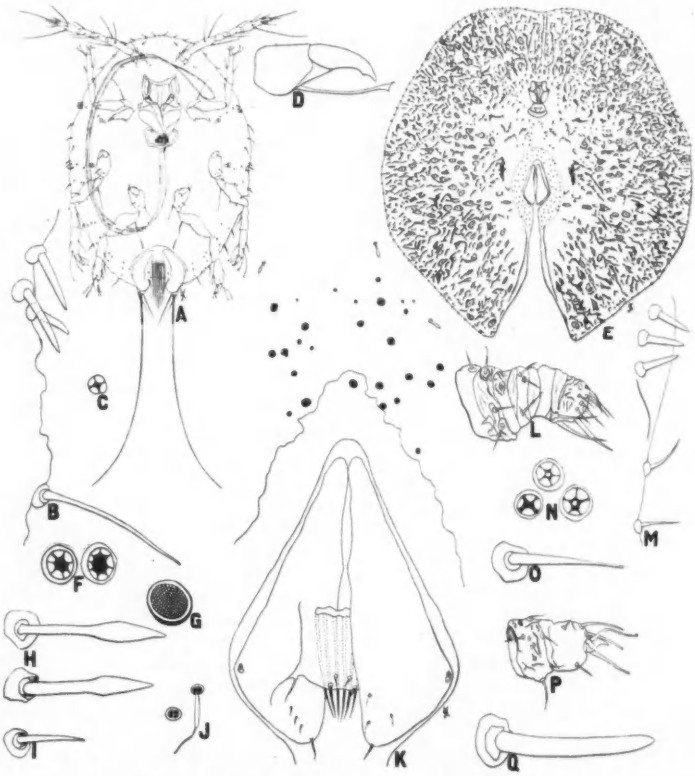

FIG. 4. *Neolecanium derameliæ*, new species.

A, larva, outline from below, × 80; B, same, spiracular spines and one marginal seta, × 1000; C, same, spiracular disk pore, × 1000; D, same, claw, × 1000; E, adult female, outline, optical section, showing shape, location of parts and partial chitinization, × 18; F, same, disk pores from beneath anal plates, × 1000; G, same, dorsal pore from near anal plates, × 1000; H, same, dorsal spines, × 1000; I, same, dorsal seta, × 1000; J, same, minute dorsal bilocular pores, × 1000; K, same, anal plates, ventral to left, × 153; L, same, antenna, × 353; M, same, spiracular region at margin, × 433; N, same, spiracular disk pores, × 1000; O, same, marginal seta, × 1000; P, same, leg, × 353; Q, same, spiracular spine, × 1000.

IV, 25; V, 18; VI, 53; length of leg 215μ, legs normal, slender, both pairs of digitules present, slender, slightly knobbed at tips, claw with distinct denticle; each spiracle connected to spiracular spines by a row of three or four quadrilocular disk pores; marginal setæ slender, each about 21μ long, apical seta about 400μ long; spiracular spines in threes the middle more slender, about 14μ, the laterals stouter, about 8μ; dorsum with minute bilocular pores with tubular internal duct; ventrally with submarginal rows of tiny setæ and a single such row of minute pores; anal plates elongate triangular, the anterio-lateral margin somewhat longer, length about 72μ, width 32μ, with two small apical and one dorsal subapical seta, and one fringe seta; anal ring with 6 setæ and pores.

This species has been described from six mounted and several unmounted specimens collected on unknown host at Cooper's Place, Rio Aojeta, C. Z., August 19, 1923, from beneath sheds of *Azteca* sp., by James Zetek (Z-2196).

The types are in the U. S. National Collection of Coccidæ.

The conspicuous feature of the mounted insect is the peculiarly shaped, scattered, dorsal spines described above. The true relationships of the species are difficult to suggest and the generic assignment indicated above will, as already noted, probably prove to be only temporary.

Genus **Akermes** Cockerell.

Akermes cordiæ, new species

Occurring in hollow swellings of the host, sometimes attended by ants.

Adult female.—Very irregular in shape, length about 4 to 4.5 mm., width about 3 mm., height about 2-2.5 mm., color above uniform dark reddish brown, faintly mottled with lighter coloring over the disk of the dorsum, somewhat blackish around anal plates, ventral surface of body shading from light reddish brown at margin to pale yellow or even flesh color in the deeply invaginated ventral abdominal area; margin of the ventral area fairly heavily chitinized, the spiracular grooves sharply defined and deep, usually filled with waxy secretion; body surface shining, faintly rugose, indistinctly but rather uniformly pitted over disk, deeply and conspicuously pitted along margin; derm remaining yellow-brown and rather densely chitinized even after considerable treatment with caustic potash, exhibiting numerous pores of at least two kinds, the most numerous small, round to oval, apparently simple, or more or less distinctly bilocular pores, very abundant over the whole dorsal surface and, many, but less numerous, much larger, circular disk pores of indeterminate structure, each surrounded by a heavy collar and a chitinized area; the conspicuous marginal pits of the

untreated specimens appearing in mounted individuals as equally conspicuous, large, deep pits, each surrounded by a more or less distinctly thickened area in the chitin; antennæ very much reduced, length about

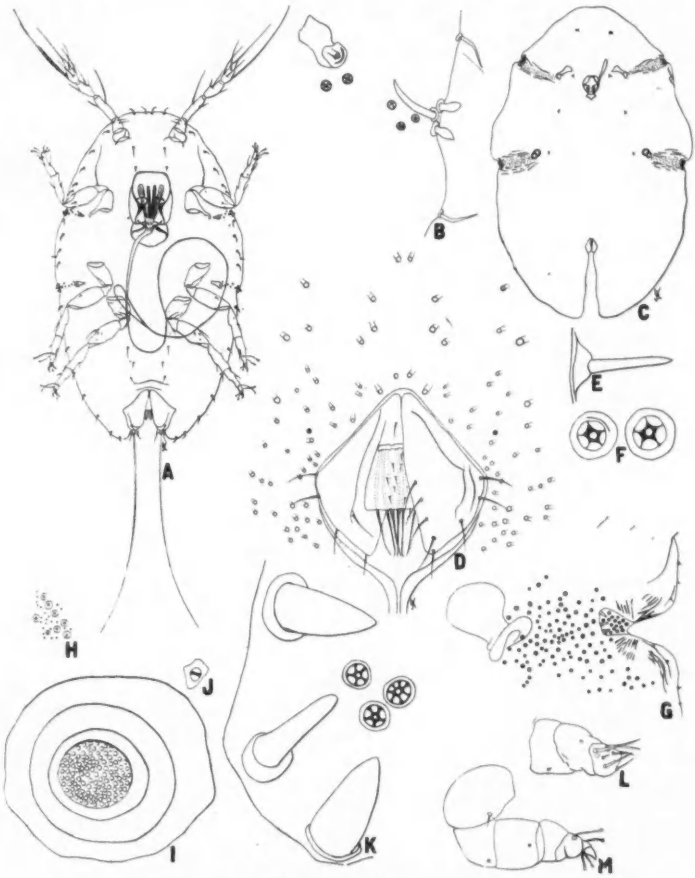

FIG. 5. *Akermes cordiæ*, new species.

A, larva, outline from below, × 80; B, same, spiracle to margin area, × 433; C, adult female, outline showing position of parts, × 12; D, same, anal plates, ventral to left, × 153; E, same, marginal seta, × 1000; F, same, quinquelocular disk pores, × 1000; G, same, region between spiracle and margin from below, the overlap of pores and spiracular spines onto dorsal surface indicated by boundary line, × 80; H, same, small section of dorsal derm showing pore pattern, × 40; I, same, large dorsal pore, × 1000; J, same, small dorsal pore, × 1000; K, same, spiracular spines, × 1000; L, same, antenna, × 220; M, same, leg, × 220.

68μ, width about 43μ, very indistinctly segmented, with a cluster of spines and setæ at apex; legs likewise much reduced, approximating the antennæ in size, claw and tarsal digitules present; spiracles rather large, rather heavily chitinized each joined to a distinct marginal spiracular incision by a rather heavy band of pores; mouth parts small, not unusual; body dorsally with setæ occasionally, these arranged in no evident order, with a considerable number of setæ ventrally beneath the anal plates; marginal setæ of moderate size, averaging about 14μ in length, separated by approximately five times their own length, each placed on a small tubercle, each nearly cylindrical for much of its length then tapering to a long conical, rounded point; spiracular spines grouped in threes, all approximating each other in length, with the median usually more slender; dorsal gland pores including the large, approximately circular type of uncertain structure, already discussed, and the much smaller, circular to oval pores, likewise of rather indefinite structure; ventral spiracular disk pores mostly quinquelocular, and with a large number of disk pores beneath the anal plates, likewise normally quinquelocular and of a size approximately equal to that of the spiracular pores; anal cleft distinct, anal plates located approximately one-fourth to one-third of the body length from the posterior apex; plates approximately straight on inner margin, outer margin rounded, broadest behind the middle, length of one about 180μ, width about 78μ, posterior third bearing about 5 relatively long, slender setæ some of these often approaching closely the posterio-lateral margin, with one apical seta, with 3 to 4 ventral ridge setæ, with a single quite large fringe seta, about 57μ in length, on each side and as many as 12 hypopygial setæ; anal ring with 8 setæ.

Larva.—Length as mounted on slide 550μ, width 357μ, total length of antennæ 180μ, of leg 285μ; of middle spiracular spine 18μ, of lateral spiracular spine 7μ, of average marginal seta 18μ, of anal plate 82μ, width of same 43μ, total length of apical setæ 393μ; antennæ normally 5-segmented, the third segment the longest; legs slender, not otherwise unusual, claw digitules knobbed at apices, exceeding the claw in length, tarsal digitules long, slender, thread-like, one inserted distinctly anterior to the other, both knobbed at apices and exceeding the apex of the claw; marginal setæ separated anteriorly by little more than their own length, posteriorly by as much as three to four times their length, all distinctly and apparently uniformly angularly curved posteriorly; spiracular spines in threes, the median much longer than the laterals, cylindrical, slightly tapering to a bluntly pointed apex, laterally much stouter, acorn-shaped, with a few, four to six, quadrilocular or, more rarely, quinquelocular disk pores between each spiracle and the margin; with a median ventral paired row of long slender setæ on the abdomen, the marginal secondary setæ slender; anal plates with a slender seta on each side of the apical seta, with one fringe seta on each side; anal ring with six setæ.

This species has been described from four mounted and a few unmounted adult females collected by Dr. Wheeler in

hollow swellings of *Cordia alliodora*, Ancon, C. Z., one lot (No. 114), including the holotype, not attended by ants, the other, (No. 216) attended by *Cryptocerus* (*Cyathocephalus*) sp. The larval description is based upon several mounted specimens.

Types are in the U. S. National Collection of Coccidæ.

This species has been assigned to the genus *Akermes* largely because of the lack of any well recognized genus with which to associate it. The whole complex of the Neotropical species of *Akermes*, *Neolecanium*, *Toumeyella* and various species in other genera at present forms a conglomeration of species and species names which are only rarely based on a precise morphological foundation and which cannot be satisfactorily identified nor segregated until the group to which they belong is very critically studied.

Genus **Cryptostigma** Ferris.

Since this genus evidently includes a natural group of species, the writer has accepted it for use in this paper without critical consideration of its status in relation to other described genera in the subfamily.

Cryptostigma biorbiculus, new species.

Occurring within hollow stems of the host, attended by ants.

Adult female.—Described from mounted specimens only, nothing available regarding external appearance; maximum length as mounted on slide 5 mm., maximum width 4 mm., irregularly oval, more or less distinctly narrowed anteriorly; derm apparently remaining incompletely chitinized at maturity, heavy chitinization occurring only in a band around the body margin, in the area immediately surrounding the anal plates and in two conspicuous, oval disks placed on the median line one a little anterior, the other a little posterior to the mouth parts as the latter are normally situated, derm densely crowded with small, approximately circular, chitinous disks each having a large bilocular tubular pore at its center; anterior to anal plates with a few chitinous disks of irregular shape and size each bearing a number of simple pores; antennæ very much reduced, very indistinctly segmented, with a cluster of setæ at apex maximum observed length 90μ; legs also very much reduced with the parts more or less evident; claw fairly well developed but small, strongly curved; claw digitules present, exceeding the claw in length; dorsal digitules present extending beyond apex of claw; average total length about 100μ; spiracles stout, but not conspicuously enlarged, placed quite close to the spiracular incision, the margin of each incision rather heavily chitinized and with a considerable number

of large disk pores, normally with 8 loculi between spiracle and incision; mouth parts not unusual; marginal setæ stout, tapering gradually from base to apex, apex round, average length about 10μ but variable; no spiracular spines observed, these apparently wanting; no dorsal setæ observed, ventrally with a considerable cluster of setæ beneath the anal plates and quite a few scattered over the surface, these fairly large;

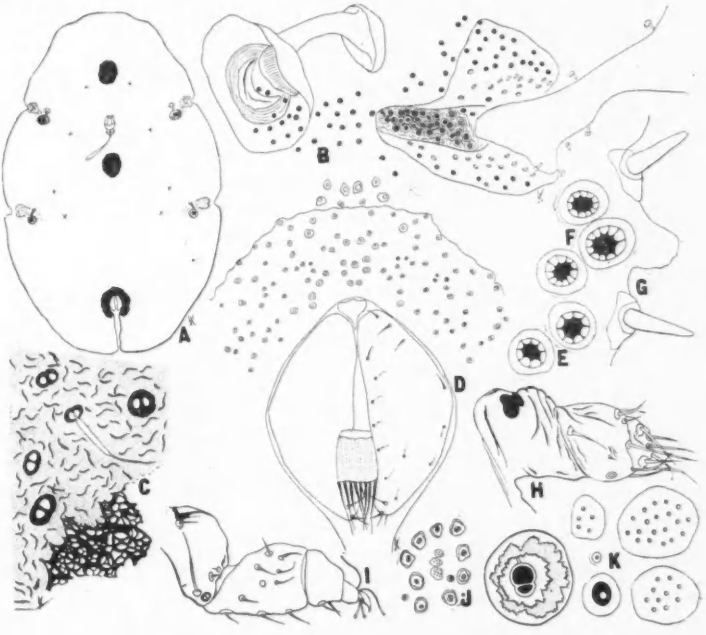

FIG. 6. *Cryptostigma biorbiculus*, new species, all adult female.

A, outline, optical section, showing parts and particularly the two chitinized plates, × 12; B, spiracular region of margin, × 153; C, portion of one of plates showing something of structure, × 1000; D, anal plates, ventral (incomplete) to left, × 153; E, spiracular disk pores (2), × 1000; F, disk pores from beneath anal plates, × 1000; G, marginal setæ, × 1000; H, antenna, × 307; I, leg, × 307; J, portion of derm showing dorsal pores, × 153; K, dorsal pores and pore plates, × 1000.

dorsum crowded with 8-shaped disk pores surrounded by chitin as already mentioned, and interspersed among these many, but less numerous, single pores with narrow collar and long tubular internal duct and finally with, apparently, three paired clusters of chitinized plates each bearing several tiny tubular pores; ventrally with the large disk pores already described in the spiracular region and with transverse bands of similar disk pores around and anterior to the anal

plates these last with heavy rim and normally 10-11 loculi; anal plates each elongate half oval, length about 195μ, width about 115μ; dorsal surface bearing about 15-18 setæ scattered over the whole surface, but most numerous in a row along the inner edge, number and position of ventral ridge setæ and fringe setæ not determinable from material available, but with two fringe setæ close to the middle line, apparently without hypopygial setæ, but with the area in which these usually occur with tiny aciculations as in the species *quinquepori;* anal ring small, with pores and 10 setæ.

This species has been described from four specimens mounted on slides, two from Ancon, C. Z., in *Cordia alliodora*, with *Pseudomyrma sericea*, May 5, 1923, (No. 110) (holotype and paratype), and two from Frijoles, C. Z., March 28, 1923 in the same host, with *Azteca longiceps* (No. 232) (paratypes), all collected by Dr. Wheeler. The species was also collected again by Dr. Wheeler in *Cordia alliodora*, at Corozal, C. Z., July 12, 1924, (No. 666).

The types are in the U. S. National Collection of Coccidæ.

In the characters which are available for observation this species appears to resemble Newstead's *quinquepori* quite closely; it differs conspicuously however, in possessing only two median instead of five submarginal dorsal disks. There is a further quite evident difference in the character of the dorsal pores as the 8-shaped pores of *quinquepori* are somewhat invaginated and are not surrounded by a chitinous disk as in this species.

Specimens believed to represent immature stages of this species were also collected in Ancon, C. Z., on the same date and in the same host as was the preceding material in the collection with *Azteca* sp. (No. 115).

Cryptostigma quinquepori (Newstead).

Three lots of specimens of this species have been examined in connection with this study, one collected in *Cecropia* sp., from Paramaribo, Dutch Guiana, with *Azteca alfari cecropiæ* Forel by G. Stahel, and two collected in *Triplaris surinamensis* from Blairmont, Berbice, British Guiana, February 14, 1924, by H. E. Box.

The specimen from Dutch Guiana varies from the typical condition in that the intermediate "pores"—always much smaller than the other three—are apparently obsolete. No other structural differences have been noted.

Cryptostigma reticulolaminæ, new species.

Occurring in hollow swellings of the host twigs, associated with ants.

Adult female.—Varying in size and shape, average length 5 mm., width 4.5 mm., height 2.5 mm., deeply invaginated beneath in the abdominal region; color of alcoholic specimens dark reddish brown with blackish infusion along margin and anterior to anal plates; body surface smooth, rather shining, bearing numerous tiny pits corresponding in position to the chitinized derm areas described later; derm remaining rather dark yellow brown after treatment with caustic potash, and showing many small, much darker, irregularly circular to oval, chitinized patches arranged in clusters to form a definite pattern, and each surrounding a fairly large pore opening, these structures apparently actually pits with dark colored wall, largest at outer surface and tapering to the small pore opening at inner end; antennæ not located in the material available, but undoubtedly very much reduced; legs extremely reduced, each represented by nothing more than a tiny patch of pores and setæ with a minute thumb-like claw and two comparatively large, slender digitules; spiracles large, closely attached to, and the structure much obscured by, the large, heavily chitinized circular to oval plate marking each spiracular region of the body margin; no definitely recognizable marginal setæ located, but setæ in the proper region slender, small, long tapering to a point; spiracular spines apparently wanting; dorsal setæ few in number, widely scattered, most numerous around anal plates, long, peg-like with bluntly rounded apices; ventral setæ small, slender, tapering, acute, more numerous than dorsal; dorsal pores including the large and small sorts already discussed, the latter furnishing the openings for slender tubular ducts, rather numerous but apparently scattered, and a considerable cluster of quinquelocular disk pores in the spiracular region, mostly in the center of the large chitinized plate; the disk pores usually found beneath the anal plates apparently lacking; anal cleft a groove only a little longer than the plates, the remainder completely obliterated; anal plates of moderate size, placed one-fourth to one-fifth of the body length from the posterior apex, length of each about 175μ, width about 110μ, shape triangular, the inner edge practically straight, the caudo-lateral edge somewhat longer than the cephalo-lateral; anterior portion of each plate more or less distinctly reticulated as in figure with three dorsal and one apical setæ on the posterior half of each plate, with three long, slender ventral ridge setæ each about 35μ, with a single, slender, fringe seta on each side about 28μ, and with six to nine relatively long, about 25μ, hypopygial setæ; anal ring with pores and 10 setæ, the longest about 125μ.

Larva.—Length as mounted 820μ, width 528μ, total length of antenna 268μ, of leg 403μ, of average marginal seta 25μ, of average spiracular spine 14μ, (all subequal), length of anal plate 107μ, width 53μ, maximum length of apical seta 554μ; body rather stout oval, the derm, even in embryonic specimens, showing a pronounced irregular areolation

dorsally; antennæ slender, the third segment very long; legs not unusual, the claw slender, both claw and tarsal digitules thread-like, definitely surpassing the apex of the claw, knobbed at apices and the tarsal digitules arising opposite each other; marginal setæ stiff, spine-like,

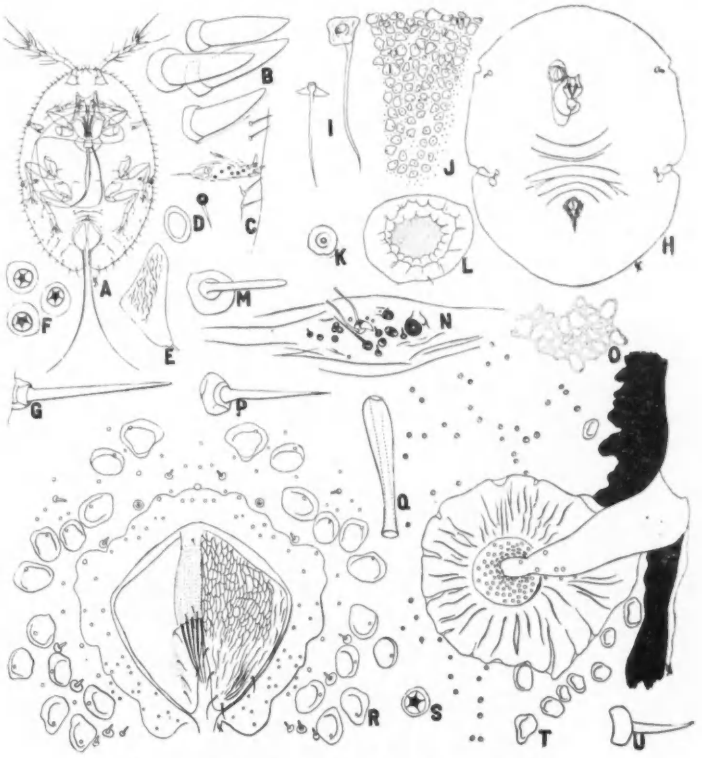

FIG. 7. *Cryptostigma reticulolaminæ*, new species.

A, larva from below, × 40; B, same, posterior spiracular spines, × 1000; C, same, spiracular region, × 153; D, same, dorsal pores, × 1000; E, same, anal plates from above, × 153; F, same, spiracular disk pores, × 1000; G, same, marginal seta, × 1000; H, adult female, outline optical section, showing shape and some parts, × 12; I, same, dorsal pores, × 1000; J, same, portion of derm showing arrangement of heavy pores and small pores, × 40; K, same, minute dorsal pore, × 1000; L, same, large heavily chitinized dorsal "pore," × 353; M, same, dorsal seta, × 1000; N, same, leg, × 433; O, larva, portion of dorsal derm showing areolations, × 1000; P, adult female, ventral seta, × 1000; Q, same, dorsal tubular pore, × 1000; R, same, anal plates and adjacent region, ventral to left, × 153; S, same, spiracular disk pore, × 1000; T, same, spiracular marginal area, × 153; U, same, marginal seta, × 1000.

set about their own length apart; spiracular spines stout, basal portion nearly cylindrical, apex long conical, pointed, with three opposite each anterior and four opposite each posterior spiracle; spiracles not unusual, each joined to margin by a chitinized groove bearing four or five quinquelocular disk pores; derm dorsally with a submarginal row, well set in, of apparently simple pores, each with slightly chitinized rim, and with, for a larva, a considerable number of scattered, long, slender, tubular ducts; ventrally with a submarginal, an intermediate and a submedian row of setæ on each half of the body; anal plates triangular, the cephalo-lateral margin somewhat longer than the caudo-lateral; dorsal surface showing distinct elongated spindle-shaped areolations, with a short seta on each side of large apical seta, with a single fringe seta on each side, hypopygial setæ apparently lacking; anal ring with six setæ.

The adult female of this species has been described from four specimens or parts of specimens mounted on slides and the larva from a number of individuals similarly mounted. The collection data accompanying the specimens is as follows: Frijoles, C. Z., in hollow swellings of *Cordia alliodora* attended by *Azteca longiceps*, March 28, (No. 232) (holotype and paratypes); and Ancon, C. Z., in hollow swellings of *Cordia allidora* attended by *Azteca longiceps*, March 18, (No. 186) (paratypes), both collected by Dr. Wheeler. Additional collections, made by Dr. Wheeler in 1924 in *Cordia alliodora*, include one record from Agua Clara Reservoir, Ft. Davis, C. Z., July 5, (No. 607), and one from Barro Colorado Id., July 21, (No. 730).

The types are in the U. S. National Collection of Coccidæ.

This species has been placed in the genus *Cryptostigma* primarily because the spiracular complex of the adult female has at least a superficial resemblance to the arrangement found in that genus. It is by no means certain, however, that this relationship is actually anything more than superficial, and, in fact, some of the other adult and larval characters of this species diverge quite distinctly from the condition apparently characteristic for these stages of the group of species making up the genus *Cryptostigma*. However, as noted under *Akermes*, the whole classification of the subfamily including these forms is in a state which largely prohibits any discussion of the true relationship of new species.

Cryptostigma secretus (Morrison).

Ferris has recently directly (in litt.) and indirectly (10, p. 283) placed his *Cryptostigma ingæ* which is identical with the

above, but was described about one month later, as a synonym of *Pseudophilippia inquilina* Newstead. This synonomy is very probably correct, but, as the writer has pointed out (9, p. 148), Newstead's description disagrees with specimens of *secretus* on a sufficient number of points to prevent their definite association. It has therefore seemed best to retain the name given above until the synonomy suggested can be definitely proved or disproved through a direct comparison of type specimens of both species.

The species is represented in the collection considered here by a single lot of material collected by Dr. Wheeler in swellings of *Cordia alliodora*, Ancon, C. Z., with *Azteca longiceps* (No. 109).

Genus **Saissetia** Desplanches.

Saissetia hemisphaerica (Targ.).

Two lots of material of this species are present in Dr. Wheeler's collection, both on young stems of *Clerodendron siphonanthus*, Balboa, Canal Zone, with *Azteca* sp., collected April 11, 1923, (No. 336, 337).

Saissetia auriculata, new species.

Occurring on the twigs of the host.

Adult female.—Length 8 mm., width 6 mm., height about 5 mm., profile along median line triangular with rounded apex, this with a single, distinct, transverse ridge; outline of body as viewed from above uniformly oval except for two somewhat protruding marginal lobes one on each side of the body near the anterior end; upper surface very dark, almost black, apparently covered by a thin film of wax secretion, shining, surface faintly rugose; ventral surface plane or slightly concave over much of its area, this portion distinctly, but not heavily, chitinized, an elongate central opening and two grooves joining this and leading to the margin beneath the little lobes, giving access to a deep, membranous, invaginated pouch; dorsal derm clearing only a little on treatment with caustic potash, showing crowded large easily detached areolations, similar in appearance to those of *Saissetia nigra* and beneath these a uniform dark brown layer bearing only tiny pores coinciding with the center of the areolations; exterior portion of ventral derm remaining yellow-brown after treatment, showing numerous scattered clear pores; antennæ small, 6-segmented, not otherwise unusual; legs small, otherwise normal; posterior spiracles small, weakly chitinized; anterior spiracles not located; mouth parts small, situated on a fleshy tubercle; no dorsal setæ located; marginal setæ stout, tapering, spine-like; both

sets of spiracular spines present, in threes, the median much larger and stouter; dorsal gland pores not noted, ventral surface with an occasional tiny tubular duct, and with a few minute quinquelocular disk pores in a loose row extending in from the spiracular spines ventrally, disk pores beneath the anal plates not located; with at least 20 and probably more submarginal tubercles around body margin; anal plates small, half oval, outer angle not even indicated, each with 4 dorsal setæ at the posterior apex, one large and 4 small ventral ridge setæ, and with eight fringe setæ, the two outer pairs larger, the other two pairs on the fold near the middle line; anal ring small, with pores and 8 setæ; hypopygial setæ wanting.

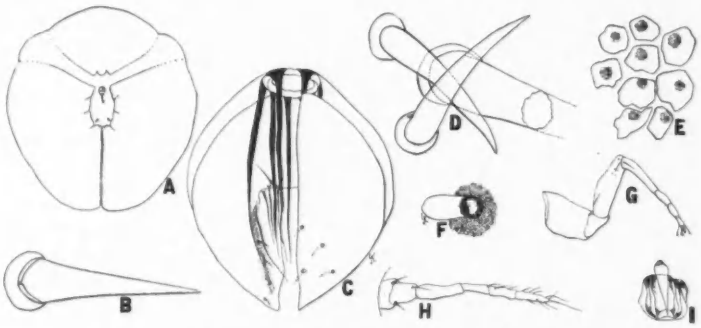

FIG. 8. *Saissetia auriculata*, new species, all adult female.
A, outline of body from beneath, showing flattened surface and boundaries of deep ventral and spiracular cavities, × about 4; B, marginal seta, × 1000; C, anal plates, ventral to left, × 153; D, spiracular spines, × 1000; E, derm areolations, × 80; F, posterior spiracle, × 80; G, leg, × 77; H, antenna, × 77; I, submarginal tubercle, × 433.

This species has been described from a single specimen collected by Dr. Wheeler at Las Cascadas, C. Z., on outside of twig of *Triplaris cumingiana*, (No. 170).

The type is in the U. S. National Collection of Coccidæ.

While it is ordinarily very poor practice to describe a species of scale insect from a single specimen, the form characterized above has seemed sufficiently distinctive to permit this course. According to present day conceptions the species agrees fully with *Saissetia*, the derm, as noted, closely resembling that of *S. nigra*, but it is readily separated from all the species of the genus known to the writer by the combination of its large size, short conical shape, with single tranverse dorsal ridge, lobe-like marginal projections and partially flattened and partially deeply invaginated ventral derm.

Genus **Cyclolecanium,** new genus.

A genus belonging in the subfamily Coccinæ and probably somewhere among the genera comprising the old section III, including the naked forms of this subfamily; exact relationships not certain, but possibly to be associated with the complex including *Akermes, Toumeyella, Neolecanium* and similar forms.

Differentiated from all genera known to the writer in that the dorsal surface proper is restricted to a relatively small, heavily chitinized disk placed in the middle of the upper face of the body, the ventral surface proper covering the remainder of the top, the sides and the under surface of the body, this modification producing an inversion and an apparent dislocation of the spiracles and the spiracular grooves; this appearance suggesting the genus *Lecanochiton* Maskell, but the available material of the latter inadequate for a critical comparative study and the resemblance apparently superficial; adult female with body, in general, flattened globular at maturity, heavily chitinized except in the mid-ventral area; legs and antennæ much reduced; spiracles located dorsally or subdorsally, inverted, a groove from each running inwards to the restricted dorsal surface; marginal spines short and stout, apices rounded; spiracular spines apparently wanting; true dorsal setæ apparently wanting, ventral setæ present; spiracular and ventral abdominal disk pores both quinquelocular; anal plates stout triangular, with a few apical and subapical dorsal and ventral ridge setæ, a single fringe seta on each and a few hypopygial setæ; anal ring with pores and 10 setæ.

Intermediate stage female.—With morphological details in general similar to adult, but the spiracles and their grooves in normal position, and three small spiracular spines present opposite each spiracle.

Larva.—Stout oval; antennæ normally 5-segmented, the third longest; legs not unusual; with three spines, one longer, opposite the anterior spiracles, and four, one longer, opposite the posterior; marginal setæ stout, about equalling longest spiracular spine.

Type of genus **Cyclolecanium hyperbaterum,** new species.

Cyclolecanium hyperbaterum, new species.

Occurring normally within the myrmecodomatia of the host, attended by ants.

Adult female.—Fully matured adult very high convex, usually irregular in shape, dorsal disk, that is the true dorsal surface, black, remainder of body dorsally and laterally dark reddish brown sometimes appearing almost black, this shading off more or less ventrally to a paler reddish brown then to yellowish-brown with the venter still paler; size quite variable, depending on degree of lateral compression, averaging about 3.5 mm. high, by 4.25 mm. long, by 3.25 mm. wide,

the well marked dorsal disk usually circular to elongate oval in shape and the four spiracular grooves deeply impressed and running from the sides of the body to the dorsal disk, the whole surface appearing smooth and shining as if highly polished; derm after treatment with caustic potash remaining heavily chitinized and dark reddish to yellow-brown in color; dorsal disk densely pitted by minute pores arranged in indefinite irregular radiating bands, remainder of derm with pores rather widely scattered and apparently not in definite arrangement; morphological details very largely obscured in the older specimens, most of those given therefore obtained from adult but undistended females; antennæ very short, very obscurely 4-segmented, bearing clusters of spine-like setæ at apex, total length about 35μ, width at base about 28μ; legs small triangular in outline very much reduced, claw small, conical, digitules developed, these about four times claw length, total length of leg about 40μ, width at base 33μ, length of digitules about 14μ; each spiracle placed at lower end of a heavily chitinized groove running between margin of the disk and the spiracle with many pores, each at the inner end of a small tube, crowded in a narrow band between spiracle and disk, spiracles not unusually large, but rather heavily chitinized and with a broad bar; mouth parts small, rather weakly chitinized; marginal setæ (along edge of disk) small, fairly stout, rather blunt-tipped, separated by about twice their own length, average length about 7μ; spiracular spines not observed, and apparently wanting; with a few widely scattered, small, slender setæ over the lateral areas of the derm, none observed on disk, and with numerous, long, slender setæ of varying sizes ventrally beneath anal plate region; spiracular disk pores quinquelocular, ventral abdominal disk pores also quinquelocular, but larger than spiracular; with a few scattered tubular ducts present laterally, but structure of these not determinable, the very numerous minute pores of the disk possibly the openings of additional tubular ducts; disk anterior to anal plates with a small, indistinct cluster of larger circular openings somewhat suggesting in appearance the pores found in the same position in many other species of the subfamily; no structures comparable to submarginal tubercles of some species observed; anal plates placed a little behind the middle of the dorsal disk, the anal cleft distinct not fused, and continuous from the disk down around the posterior face of the body to the membranous ventral skin; anal plates triangular in outline, average length of one about 140μ, width about 70μ, anterio-lateral margin distinctly longer than posterio-lateral, inner margin straight or nearly so, with 4 to 5 dorsal setæ, all near the apex of the lobe, 5 to 7 ventral ridge setæ located well down from the apex, a single fringe seta on each side, and a maximum of 8 relatively large hypopygial setæ; anal ring normally bearing pores and 10 setæ, the longest about 70μ in length.

Intermediate stage female.—Much smaller than the adult, pale yellow or somewhat darker brown in dried specimens, frequently covered by a thin film of glassy secretion, flat or slightly convex, derm membranous, irregularly circular to somewhat oval, average length 1.4 mm., width 1.3 mm.; antennæ, as in adult, very indistinctly seg-

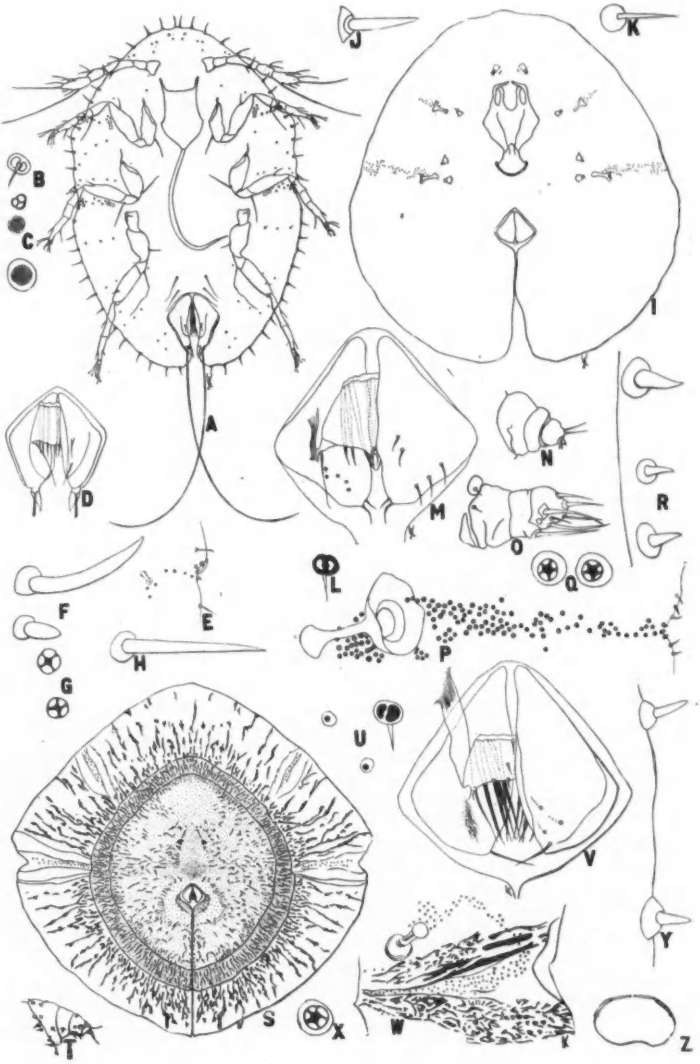

FIG. 9. *Cyclolecanium hyperbaterum*, new genus and species.

mented and bearing a cluster of rather stout spines and setæ at apex, with a maximum observed length of 35μ, and a width of 17μ; legs very much reduced, as in adult, short conical, with four distinct parts, claw conical, claw digitules present, tarsal digitules thread-like about 14μ long; spiracles normal in shape, with slender bar and expanded outer end, mouth parts not unusual, beak very short, stout and apparently 1-segmented; marginal setæ separated by approximately twice their own length, rather stout, each about 12μ long, pointed at apex; spiracular spines represented by a set of three elongate conical spines shorter and stouter than the marginal setæ, placed opposite each spiracle; dorsally with a considerable number of scattered slender setæ averaging distinctly smaller than the marginal setæ, ventrally with some slender setæ beneath the anal plates and near the antennæ at least; dorsally with numerous, but scattered, tiny bilocular pores distributed rather uniformly over the body surface; ventral spiracular disk pores quinquelocular; anterior row from anterior spiracle to margin incomplete; anal plates located a little behind the middle, in general resembling those of adult in shape, with about 3 or 4 dorsal, 4-6 ventral ridge, one fringe seta to each plate and a total of 3 or 4 hypopygial setæ; anal ring small, with 8 setæ and some pores.

Larva.—Average length as mounted 640μ, width 450μ, length of apical seta 445μ, average marginal seta 21μ, longest spiracular seta 21μ, small spiracular seta 7μ; total length of antenna 190μ; length of parts of middle leg in microns: coxa 78, trochanter 30, femur 100, tibia 64, tarsus 57, claw 22, claw digitules 23, tarsal digitules 36; body uniformly oval; antennæ normally 5-segmented, III the longest; legs slender; mouth parts normal; spiracles oval each with a single row of quadrilocular disk pores between it and margin; marginal setæ relatively large and stout, acutely pointed; anterior spiracular spines in threes, the median about two or three times the length of the others, posterior spines usually in fours, with one much longer and one very slightly larger than the other two, more rarely in threes as in the anterior spiracle; body with a few ventral setæ but apparently without dorsal

EXPLANATION OF FIGURE 9.

A, larva, outline from below, × 77; B and C, same, body pores, × 1000; D, same, anal plates, ventral to left, × 153; E, same, spiracular region, × 153; F, same, spiracular spines, × 1000; G, same, spiracular disk pores, × 1000; H, same, marginal seta, × 1000; I, intermediate stage female, outline, optical section, × 40; J, same, marginal seta, × 1000; K, same, dorsal seta, × 1000; L, same, bilocular pore, × 1000; M, same, anal plates, ventral to left, × 220; N, same, leg, × 353; O, same, antenna, × 353; P, same, spiracular-marginal region, × 353; Q, same, spiracular disk pores, × 1000; R, same, spiracular spines, × 1000; S, early adult female, before distension, outline from above, × 18; T, same, leg, × 220; U, same, dorsal pores, × 1000; V, same, anal plates, ventral to left, × 220; W, same, spiracular-marginal region from left side of body, × 40; X, same, spiracular disk pore, × 1000; Y, same, marginal setæ, × 1000; Z, same, hypothetical cross section through anal plates and posterior spiracular region, showing position of true dorsal surface and the inversion and apparent dislocation of the spiracles.

setæ, although with scattered 8-shaped pores dorsally; anal plates rather elongate slender, inner margin straight, the anterio- and posterio-lateral margins about equal in length, with a very long apical seta and two much shorter subapical setæ, one on each side of the larger; anal ring with six setæ.

This species has been described from 17 lots of material collected by Dr. Wheeler in 1923, in hollow swellings of *Cordia alliodora* at Ancon, C. Z., accompanied by *Pseudomyrma sericea* (No. 110); by *Camponotus* sp., (No. 210); by *Azteca longiceps* or *Azteca* sp., (No. 108, 109, 115, 186, 214 and without number); at Red Tank, C. Z., accompanied by *Crematogaster* sp., (No. 147); by *Azteca* sp. (No. 67); by *Azteca longiceps* (No. 65, 66, 141, 186 2nd lot); at Frijoles, C. Z., accompanied by *Azteca longiceps*, (No. 235); at Barro Colorado Island, accompanied by *Azteca longiceps* (No. 201) and at Pueblo Nuevo, Panama, accompanied by *Azteca longiceps* (No. 297). The holotype, an early adult female, is from lot No. 110. The remaining specimens are paratypes. Further collections, made by Dr. Wheeler during the summer of 1924, have established the following additional records for this species. In *Cordia alliodora*, Agua Clara Reservoir, Ft. Davis, C. Z., July 5, (No. 607); in *Cordia alliodora*, Gamboa, C. Z., July 9, (No. 642); in *Cordia alliodora*, Barro Colorado Id., July 21 (No. 730), and Aug. (No. 832); Ancon, C. Z., Aug. 6 (No. 847). The species occurred alone or in company with one or more of the other species discussed in this paper.

The types are in the U. S. National Collection of Coccidæ.

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THE MATING FLIGHT AND THE VESTIGIAL STRUCTURES OF THE STUMP-LEGGED MAYFLY, CAMPSURUS SEGNIS NEEDHAM

ANN H. MORGAN,
Mount Holyoke College, South Hadley, Mass.

MATING SWARM.

At Kartabo the waters of the Cayuni meet those of the Mazaruni and soon join the great lake-like Essequibo flowing north through the low lying country of British Guiana until it runs into the sea at Georgetown. These rivers are hedged in by the jungle whose undergrowth has invaded the border waters in a persistent attempt to gain more territory. Mangrove roots swing so far out from the banks that fish swim in and out among them. Moccamoccas, the giant arums, have grown out still further. Their clublike stems standing in close rank provide on gigantic scale the kind of animal shelter furnished in more modest form by our own arrow head and pickerel weeds. Many slow flowing creeks feed into these larger streams but their mouths are hidden by creepers, tangles of mangrove, and prickly shrubs, and if the currents are gentle enough they are choked by lush growths of Cabomba.

The mouths of these creeks are flooded every day and the floor of the jungle bordering the shore is covered with water for several feet back from the river by the rise of the fresh water tides. Even at Kartabo Point the daily tides are insistent reminders of the ocean forty miles away. The low tides lay bare stretches of muck and ooze, silt and silty sand, the constant siftings from the side currents of the stream. This silt is soft and loose, rich in organic material. Wherever it occurs in all our more familiar lakes and streams it is the likely dwelling place of nymphs of the burrowing and crawling Mayflies which belong to the subfamily Ephemerinæ including the largest and most familiar Mayflies such as Ephemera and Hexagenia and the white winged Polymitarcys. Among its members is the little known tropical genus, Campsurus. Though not absent from smaller streams the burrowers frequent

lakes and rivers where they live in just such silty bottom as that of the Mazaruni and Essequibo. On the Mazaruni side of Kartabo Point there is a short stretch of beach and along it the low tide leaves a band of silt which indicates the nature of the bottom over which the side waters of the Mazaruni flow. Even a glance at this shore would suggest the prediction that burrowing Mayflies might live nearby.

In the late evening of July 8, 1926, Mayflies of the species *Campsurus segnis* were flying in large numbers, above this beach. Burrowing crickets were running, or digging into the moist sand, left where the tide had gone out. They were bewildered by the spotlight and lost their direction if not their speed. Suddenly a shower of Mayflies began falling across the beams of light. In the first glare they looked like the white winged Polymitarcys alba of a genus already mentioned. Most of them protested against their fall and their wings fluttered, snowy and opaque. On the sand they toppled helpless. Many fell with outspread wings which at once clung closely to the wet sand; others were tipped over like capsized sail boats. All of them were prone. None had been able to negotiate the ground surface. As they came into the light most of them fluttered straight down from the height of twelve to fifteen feet at which they must have been flying. A few came into view at a low level, evidently borne along near the surface of the water by the breeze coming in from the river. For half an hour they kept falling upon the sand. Then the Mayfly shower ended with the same suddenness with which it began.

Was this a mating flight of fully matured imagos or a company of subimagos which had but just shed their nymphal skins and flown toward the light? Their differing maturity seemed to indicate a mixture of both mating and emerging flights. The cause of the ground flop was seen as soon as one of the Mayflies was picked from the sand. The females did not at first appear to have any legs at all. Only two males were found and these were lying with their front legs extended before them but they were as devoid of other legs as the females and nearly as helpless. This dearth of males argued against there having been any mating flight in progress, since with Mayflies that is characteristically a male performance. In the lake species, *Ephemera simulans*, the flight is predominantly male while in the small species, *Choroterpes basalis* and *Baetis posticus*, males make up at least half of the swarms. The

females of Campsurus were borne down to the ground by their heavier bodies and the weight of their eggs, while it may have been that the lighter bodied males had flown on into the trees. This seemed the more probable because many of the females had yellow packets of eggs projecting from the openings of the oviducts. Such egg packets are carried by many kinds of Mayflies and their appearance always indicates that the short span of adult life is about over, that mating has occurred, or if not, at least that full maturity has been reached and the eggs can no longer be retained. One of the Mayflies which is most commonly seen carrying egg packets is the tiny Caenis which is often caught and hung, eggs and all, in the meshes of spider webs upon bridges and street lamps. The egg masses of Campsurus were carried not only by imagos which had shed their subimago skin entirely but by those over which the subimago skin still fitted completely or partially. When the egg packets were removed from these females, the walls of the oviducts were found far everted with the Malpighian tubules pushed through the membranes and hanging into the air as if the eggs had been forced out so convulsively that the ducts had been torn and the tubules projected through their walls. The females collected had probably swarmed and had been flying over the water to deposit their eggs when they were carried in toward the light.

The subimago stage of *Campsurus segnis* is probably of brief duration, far different from that which is characteristic of its related *Hexagenia bilineata* and *Ephemera simulans* in which this stage lasts twenty-four hours or more. In these and in many other species this subimago period is the one in which there is a rapid elongation of the legs and caudal setæ. These changes are most obvious in the males, the lengthening slenderness of whose front legs is zigzagged across the encasing subimago skin as if in a stocking much too short. No such growth of the legs seemed to have occurred in these Campsurus subimagos.

In the extreme specialization which *Campsurus segnis* has attained the brevity of its aerial life has been a necessary parallel to the abbreviation of its legs. The adults are entirely dependent upon their wings for existence. Since they have no legs to rest upon neither males nor females can alight upon anything and if they are forced down there is little chance that they can ever fly again.

VESTIGIAL LEGS AND MODIFICATIONS FOR REPRODUCTION.

In 1876 Eaton published his "Notes on the legless condition of Campsurus" and very briefly commented upon specimens of "Campsurus and some of its allies" in which all of the legs had been cast off by some of the females, while in others the front pair of legs had been retained "as it had seemingly in all the males." (Eaton 1876, p. 7). In his "Revisional Monograph of Recent Ephemeridæ" he characterized the genus and described eight species but neither in genus nor species descriptions did he mention the extreme atrophy of the legs which he had previously noted (Eaton 1868, 1876). Although he carefully defined the color of the legs of species of Campsurus and referred to the "fore legs yellowish like the hinder legs" in the females of *Campsurus decoloratus* Hàgen (Eaton 1883, p. 41) he made no comment as to any vestigial condition. He figured the head, wing, genitalia and front leg of the imago male *Campsurus albifilum* Walker (Eaton 1883 Pl. V., Fig. 8a) but did not there mention any peculiar condition of the middle and hind legs. In 1913 a figure of an unnamed species of Campsurus was published by the author (Morgan 1913 p. 394). This was drawn from a specimen kindly loaned by Dr. J. G. Needham. This male imago showed the vestigial middle and hind legs very clearly but some of its structures were broken and so far as the author is aware no description of it has been published. Under the caption, "An Adult 'Peg-leg' Campsurus sp?", Dr. Needham included this figure in his interesting paper (Needham 1920, Pl. LXXXI, Fig. 57) on the burrowing Mayflies of the subfamily Ephemerinæ. In connection with his key to this subfamily he pointed out that "Campsurus alone has the middle and hind legs aborted," (Needham 1920, p. 277). In his key to the adults, (Needham 1920, p. 277), Campsurus was set off by the venational characters, "posterior fork of the median vein in the forewing very deep, almost reaching the base of the wing; two long simple intercalary veins between the first and second anal veins," (Pl. I, Fig. 7).

Campsurus segnis was first described in the paper. "Neotropical Mayflies" by J. G. Needham and H. E. Murphy 1924. At Dr. Needham's suggestion a further description of it has been included here, together with figures of the male and female imago The extremes of specialization which are its significant aspects will first be discussed.

This form and the genus to which it belongs present an extreme in the development of those parts directly or indirectly concerned with reproduction and a relative suppression of those not necessary to that end. The whole tribe of Mayflies includes many similar but less striking examples and the wings, front legs, and caudal setæ are always modified for action in the vertical flights undertaken during the Mayfly mating dance. Corresponding parts are less specialized in the more conservative females. Mayflies have developed mechanisms which are extremely efficient in these unique flights during which they mate. They are poor and unwilling walkers and no Mayfly can run. Their legs are always slender and delicate, giving only a weak support to the body which in many species is carried mainly by the middle and hind legs, the front ones, especially in the males, being held forward in an attitude of cordiality with no reference to locomotion or support. Observation of the male individuals of Siphlonurus, Heptagenia, Ephemerella or Chirotenetes will show the small part which the front legs take in supporting the body and will indicate their tendency to have less and less to do with the work of walking. This general ineffectuality of the legs for their original function and the shift in the use of the front legs of the male into structures accessory to mating is but a hint of the extreme disparagement of pedal locomotion which occurs in Campsurus.

In *Campsurus segnis* the middle and hind legs of the male are but stumps made up of three poorly defined segments, the terminal ones being pointed and heavily chitinized at the tips. (Pl. I, Fig. 2). These legs are too short to be of any use. When alive the insects are able to move them only a little and even when the legs have been pushed ventrally by force their tips hardly reach to the underside of the thorax. The front legs of the male are similar and not proportionately longer than those of males of other related forms of the Ephemerinæ. As is usual in Mayflies there is a twist in the joint which articulates the first tarsus with the tibia; this allows the supination of the tips of the front legs which are clasped about the female in mating. The male approaches the female from beneath and throws his front legs upward about her thorax, bending the tip of his abdomen upward, so that its ventral side comes so closely in contact with that of the female that the forceps may clasp her abdomen and the hooks of the penis, (Pl. I,

Fig. 5), be extended into the openings of the oviducts between the seventh and eighth segments.

The front, middle and hind legs of the female *Campsurus* are all aborted stumps each consisting of three weakly defined segments, (Pl. I, Fig. 4). The front legs are shortest and consist like the others of what is probably coxa, femur and tibia. What first appear to be the coxæ of the third legs are elevations of the thoracic wall, (Pl. I, Fig. 4). The ventral views of both the male and female thorax make the legs appear further ventral than they really are, (Pl. I, Figs. 2, 4). The side view of the male (Pl. I, Fig. 1) gives a truer picture of their position as it obtains in both sexes. Among the sixty females examined there were five in which one leg was noticeably longer than its mate, (Pl. I, Fig. 4). This plasticity of the leg form was further demonstrated by one female in which the left front leg was long enough to reach the front margin of the head and included a well grown femur, tibia and tarsus with tarsal claw although the corresponding front leg had but three ill defined segments and happened to be even shorter than the average, (Pl. I, Fig. 3). Reversion like this, and such irregularities of size and form are characteristic of vestigial structures and here they are good evidence of the unsteadiness of this extreme specialization which has not yet become firmly implanted in the pattern of the organism. Among Mayflies it represents an extremity of the reduction of the standing and walking function of the legs, and the predominance of degenerate limbs among which more normal ones still make their appearance.

Here pedestrianism has become as much a matter of the past as food getting became long ago among adults of the whole Ephemerid society. *Campsurus segnis* is similar to related species, such as *Hexagenia recurvata*, (Murphy 1922, Pl. VI, Figs. 88-98), in the atrophy of its mouth parts. In the female here figured all of the mouth parts are easily seen except the labrum, (Pl. I, Fig. 4). The long soft processes of the mandibles are usually crossed above the mouth cavity in which the papilla like hypopharynx is visible. They are similar to those of species of Hexagenia and Ephemera and other burrowers, and are the vestiges of the tusk like rami of the mandibles. The unknown nymph of this species must have such mandibular tusks. (Nymph of an unknown species of Campsurus. Needham and Murphy, 1924, Plate IV.) These atrophied mandibles

showed clearly in both of the captured males but were more shrunken in them than in the females, a difference which may have been due to greater maturity or to individual variation.

Like other Mayflies this species has long caudal setæ, held stiffly extended behind in flying, outriggers especially long in the males; in *Campsurus segnis* they are three times the length of the body. But the unique specialization of *Campsurus segnis* remains in the abbreviation of legs of which it is a superlative example.

Description of *Campsurus segnis* Needham

Male imago (Pl. I, Fig. 1). (Alcoholic specimen). Length of body, 10 mm.; length of setæ, 32 mm.; front legs, 4.5 mm.; middle legs, 1 to 2 mm.; hind legs, 1 to 2 mm.

General color pinkish buff, becoming subhyaline on the abdomen with brownish shadings, ridges brownish. Head, unevenly brown; eyes uniformly dark brown, small, oval and widely separated; lateral ocelli distant from each other, larger than the median ocellus; antennæ with the terminal segment hair-like and longer than the other two together. Thorax, pinkish buff, translucent; mesonotum with a broadly triangular spot of brown; metanotum tipped with brown. Wings hyaline (Pl. I, Fig. 7), costal border brownish; costa, subcosta, and radius of the front wing and costa and subcosta of the hind wing brown. Front legs with femur and tibia brown, equal or subequal in length; fore tarsi whitish, the joint between the tibia and tarsus appearing like a short segment; middle legs vestigial with three poorly defined segments, the terminal one pointed; hind legs similar to the middle pair, but slightly longer, (Pl. I, Fig. 2), legs sometimes variable in length and asymmetrical. Abdomen brownish with pale sutures, flecks and dashes; a pale mid-dorsal line extending through segments 3–10; a corresponding but more distinct line on the ventral side; conspicuous elevations on segments 2–8, each terminating at the hind angle of the sternite, showing the former position of six of the nymphal gills, (Pl. I, Fig. 1). Setæ two, hyaline, sparsely plumose at the tips. Forceps inserted each upon a separate base distinct from the posterior margin of the ninth sternite, and with a short process extending lateral to each forceps limb, (Pl. I, Figs. 5, 6). Penis strongly chitinized, curved ventrally above a pair of shorter, club-shaped processes which broaden into the spoon-shaped subgenital plates, (Pl. I, Fig. 6).

Female Imago.—Encased in subimago skin but sexually mature with the oviducts everted and abdomen cleared of eggs. (Alcoholic specimen). Length of body, 9 mm.; length of setæ, 18 mm.; length of front, middle and hind legs, each less than 3 mm.

General color buff, brownish shadings on abdomen, ridges brown. Head unevenly brown; eyes oval, same size as in the male; ocelli obscurely banded with brown, the lateral ocelli distant from each other and larger than the median one. Pronotum pale; mesonotum with

brown markings confluent in a triangular spot; front legs aborted into short stumps with three poorly defined segments, (Pl. I, Fig. 4); middle and hind legs likewise aborted and segmented but slightly longer than the first pair; legs sometimes asymmetrical, (Pl. I, Figs. 3, 4). Abdomen with lateral elevations in segments 2–7 marking the positions of nymphal gills. Setæ two, hyaline to whitish, not plumose at the tip as in the male.

Described from two males and ten females taken at Kartabo, British Guiana, July 8, 1926. The nymph is not known and no specimens nor molted skins of it were discovered.

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EXPLANATION OF PLATE.

Fig. 1. *Campsurus segnis* Needham. Adult male, showing vestigial middle and hind legs. Note the lateral elevations on the abdomen.

Fig. 2. Ventral view of adult male, showing the three segments of the vestigial legs. Front legs with four tarsi, and a twisted joint between the tibia and tarsus which allows the supination of the tarsi.

Fig. 3. Ventral view of adult female, showing asymmetry of the front legs. The vestigial mandibles have their rami extended forward.

Fig. 4. Ventral view of adult female, showing the vestigial condition of the legs and a common asymmetry. Note the vestigial mouth parts; clypeus, (labrum not visible), mandibles, maxillæ, labium, and the papilla-like hypopharynx showing within the mouth cavity.

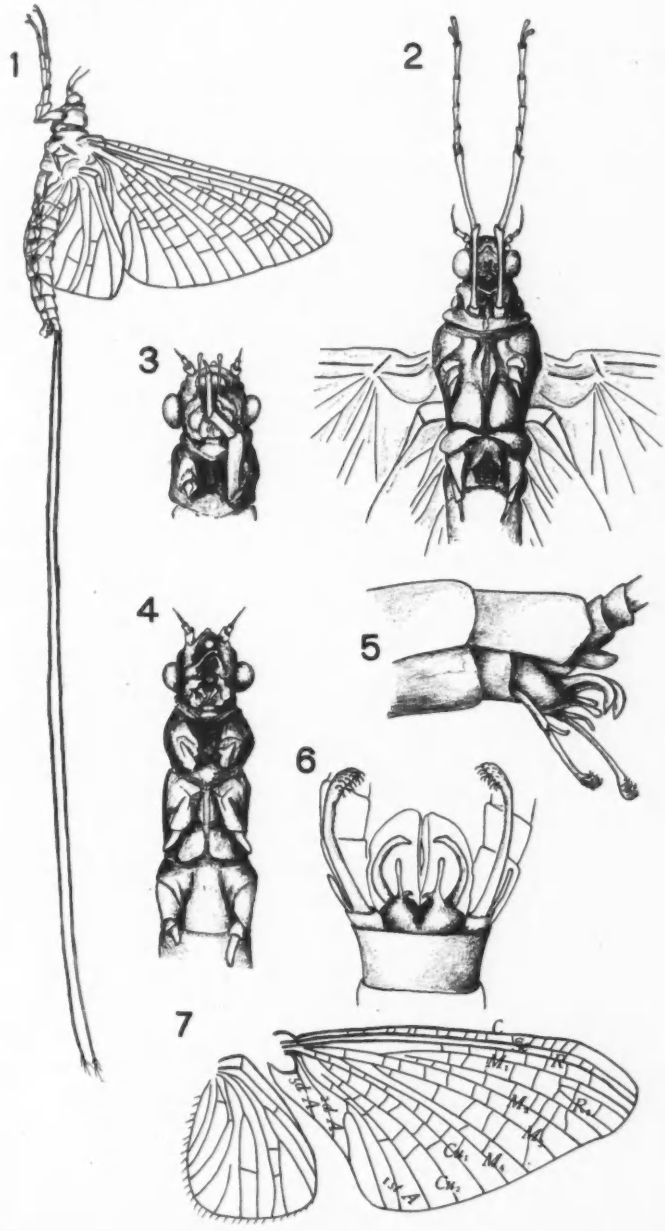
Fig. 5. Side view of male genitalia, showing each forceps limb flanked by a short process and the double penis curving ventrally over the extensions of the subgenital plates.

Fig. 6. Ventral view of the same. Note the incurving hooks upon the median edges of the subgenital plates. The plates on either side of the anus shown in outline appear disproportionately large when the body is in this position.

Fig. 7. Front and hind wing of *Campsurus segnis*. Veins named by homology with those of Hexagenia, (Morgan 1912). Note the depth of the posterior fork of the median vein.

The Mayfly Campsurus Segnis
Ann H. Morgan

PLATE I



THE REPRODUCTIVE SYSTEM OF THE WARBLE FLY HYPODERMA BOVIS DEGEER.

DON C. MOTE.
Entomologist, Oregon State College and Experiment Station.

The studies upon which this article is based were undertaken at the Ohio Experiment Station several years ago. The determination of the flies from which the drawings were made was verified by J. M. Aldrich as *Hypoderma bovis* De Geer. This year the illustrations were checked with specimens of *H. bovis* de Geer furnished by E. W. Laake.

In the main, my studies confirm those of Carpenter and Hewitt (1914). In the specimens that I studied, however, a few structures were observed that are not noted by Carpenter and Hewitt. For example, they describe only one male accessory gland while two accessory glands were present in my specimens. (Fig. 8, A. G.). Imms (1925 p. 607) evidently bases his statement "in Hypoderma there is a small unpaired globular (accessory) gland" upon Carpenter and Hewitt's observations.

The writer also observed a variation in the degree of chitinization of the various urites composing the postabdomen from that figured by Carpenter and Hewitt. The difference is especially noticeable in the paired "styles" (S. Figs. 4 and 5) which in the writer's specimens resembled more nearly those figured by Carpenter and Hewitt from *H. lineata* de Villers. The central area is less heavily chitinized and more transparent. Relative to the degree of chitinization, I suspect the variation may possibly be due either to difference in the age of the insect or in the length of time the specimens are kept in the sodium hydroxide solution. The writer also has numbered some of the urites differently.

METHODS OF WORK.

Freshly killed specimens and dried pinned specimens were used in this investigation. The dried pinned specimens were relaxed by placing the abdominal segments in boiling water for a few seconds. The postabdominal segments were removed

from the pre-abdominal segments by severing the coria with a fine needle under a binocular microscope. The postabdomen was then placed in a 10 per cent sodium hydroxide solution, boiled for a half hour or so and then left in the caustic solution for several days. The specimens were then thoroughly washed in water and run through the alcohol up to 85 per cent and gradually into glycerine. All of these operations except boiling in the hydroxide solution were carried out in Syracuse watch glasses. The specimens were examined in the watch glasses by means of a binocular microscope. The examination in glycerine in the watch glass permitted the observation of every aspect of the postabdomen which is not possible when it is mounted upon a microscopic slide.

The Male Abdominal Segments.

For convenience the abdomen is divided into two divisions, the preabdomen and postabdomen.

The preabdomen is assumed to contain urites one to five. The first urite it is assumed is fused with the thorax and is not visible. The preabdomen then consists of four visible segments, urites 2 to 5, that are entirely exposed. They are subequal in size and the largest segments of the abdomen. The fifth tergite and sternite are subequal in length and breadth. The fifth sternite is less convex and more deeply incised on the meso-caudal margin than is the fifth tergite (Fig. 1, St. 5 & T. 5). The postabdominal segments are partially, a few entirely, hidden by retraction within the fifth urite (Fig. 1).

Numbering of the Segments.

The numbering of the remainder of the segments of the abdomen is based upon the following assumptions:

1. The anus opens primitively between the eleventh tergite and its corresponding sternite.
2. The genital orifice is primitively between the ninth and tenth sternites, though the development of the penis may carry it to a point without any evident relation to the tenth urite.
3. In the diptera the style bearing segment is the tenth.

The Postabdomen.

Urite Six.—The first segment of the postabdomen is designated as the sixth segment. Of this segment the tergite alone is distinct. It is a fairly well-developed sclerite, although comparatively short and narrow. (Fig. 5, T. 6).

Urites Seven and Eight.—The tergites of these segments apparently are present though not recognizable as such in what Carpenter and Hewitt have named the intersegmental conjunctiva or coria between

the sixth and the ninth tergite. This conjunctiva, although brown in color, is not as heavily chitinized as are tergites 9 and 10. It is thickly covered with hairs similar to those covering the preabdominal segments and undoubtedly constitutes the major portion of the postabdomen normally exposed caudad of the fifth tergite. A spiracle which I take to be the eighth is located on each lateral margin of this intersegmental membrane near its line of union with the sixth tergite, (Fig. 5, Sp. 8).

Sternite Eight is the most extensive part of the ventral exoskeleton of the postabdomen. It is narrowly rounded cephalad and broad behind. Laterally its edges are produced into delicately pointed processes, almost completing a circular ring dorsad of the genital armature. It is divided into two parts; an anterior small triangular-shaped area and a posterior larger shield-shaped darker brown area. (Fig. 5, St. 8). The line of demarcation apparently is the point of attachment of the intersegmental membrane. Both Bruel and Lowne believe that the pregenital sternum belongs to the eighth segment and C. & H. agree as regards its hinder edge at least. However, if the genital orifice is between the ninth and tenth sternites, this sternite should be the ninth. There extends from the caudal edge of this sternite a pair of blunt finger-like processes, the anterior gonapophyses. (Fig. 5, G. 8).

Urite Nine is a most highly developed and interesting segment, and the largest of the postabdominal segments. It appears to consist of a single highly specialized sclerite. The highly convex tergite extends latero-ventrally into a pair of prominent processes, the styles, (S, Fig. 5). The ventral edge of each process is continued forward into a narrow chitinous band which touches the dorsal edge of the pregenital sternum, (Fig. 5, St. 8). The ninth urite is also produced ventrally on each side into chitinous triangular extensions, the apices of which nearly meet ventrad of the tenth sternite. I have named this portion of the ninth urite, sternite 9, (Fig. 4).

Also from the proximal ventro-lateral edge of the ninth tergum a relatively broad membranous sclerite extends ventro-cephalad and joins the lateral edge of sternite eight. This sclerite in its lateral aspect is crescent-shaped. In conformity with Carpenter and Hewitt's nomenclature, I have called this sclerite an epipleuron, although I question whether it is to be regarded as homologous with the pleura of the thorax. Rather I suspect it to be a part of one of the post-abdominal urites, (Fig. 5, ep.).

Tenth Urite.—In the specimens examined by the writer this segment is divided into a small delicately chitinized quadrangular sclerite (T. 10), immediately caudad of the ninth tergum and a larger and more heavily chitinized sternite (St. 10), which is quite unique in structure.

The *Tenth Tergite* is separated from the ninth tergite by a very narrow indistinct suture. Its meso-distal margin is deeply incised; laterally it articulates with the tenth sternite.

The *Tenth Sternite* (St. 10) in its dorsal aspect is subtriangular in shape, the base of the triangle deeply emarginate, the apex bluntly pointed. Between the basal emargination and the tenth tergite occurs

a thin pale membranous expansion of cuticle arranged in folds. The anus is located in the middle of this cuticular membrane. Evidently this membrane represents the eleventh urite, (U. 11). The tenth sternite is prolonged into a ventrally directed point, (Fig. 5). It is beset with many short spines. The dorsal aspect of the tail region differs considerably with the angle at which it is viewed. (Figs. 2 and 3).

The Male Reproductive Organs.

The *Testes* are small white pear-shaped bodies, each 1.25 mm. long and 1 mm. wide. They are located in the caudal portion of the second abdominal segment, one on each side of the meson. One of the bodies apparently is slightly more caudad than the other. Each testis is opaque and when compressed a white semen-like fluid discharges. (Fig. 8, R. T. & L. T.).

The *Genital Ducts* (Vasa Deferentia), (Fig. 8, V. D.)—Posteriorly each testis tapers into a slender vas deferens, one of these which we will designate the right vas deferens (r. v. d.) is longer than the left (l. v. d.). (R. V. D. 3.5 mm. to 4 mm. long; L. V. D. 2.5 mm. long). The right vas deferens passes under the cloaca and joins the left on the left side of the cloaca, forming what is commonly called the vesicula seminalis by dipteran anatomists. Thence a common duct passes cephalad, then caudad a total distance of 5 mm., passing dorsally over the rectum, then ventrad entering the ejaculatory sac on the ventral side, (Fig. 5, D. e.).

The *Accessory Glands* (Mucous Glands), (Fig. 8, A. G.)—In the region where the two vas deferens unite are situated two small pear-shaped bodies, 1 mm. long and about 0.75 mm. broad. Each is joined to the vesicula seminalis by means of a very short duct.

The *Copulatory Organ* (Aedeagus, Penis)—The innermost part of this organ is an enlarged sac, the ejaculatory sac; constricted in the middle and bulb-like at each end, (Fig. 5, S. e.). The walls of the sac are supported by a peculiar chitinous sclerite of irregular shape. I did not observe the two recurved hooks on the caudal end noted by Carpenter and Hewitt. This sclerite is broad and scoop-shaped at both ends and restricted in the middle. (Fig. 9). Posteriorly the sac is continued caudad into the proximal end of the ejaculatory duct which traverses the penis.

The *penis* consists of a tubular colorless sheath supported by a tubular sclerite, the *Theca* or *Juxta*, (Fig. 6, Th.). This sclerite projects cephalo-dorsad and caudad. The theca is continuous around the base of the organ and is produced dorsally into a strong median spine, (S., Fig. 6), the "superior apophysis" of Gordon Hewitt in the house fly. Caudally the theca extends along the sheath in paired lateral processes, terminating in hooks, (Figs. 4 and 5). Adjacent the hooks on the ventro-lateral aspect of the penis is a pair of short, narrow chitinous supports, (Th. 2).

On either side of the theca is a conspicuous chitinous process hooked at the caudal end and articulating apparently with the chitinous processes at the proximal end of the sheath, (G. 9). These are called

the "posterior gonopophyses" in agreement with Carpenter and Hewitt and Lowne.

Each posterior gonopophysis articulates with a heavily chitinized process, the tips of which are somewhat complexly hooked. Each sclerite is directed laterally and lies partially hidden by the caudal edge of the pre-genital sternum. The ventro-mesal horn of each of these processes is fused with the base of the anterior gonopophysis of the same side. Likewise a chitinized horn from each of the processes extends dorsad for a short distance along the theca on each side of the penis. Agreeing with Carpenter and Hewitt, I have designated these processes as the *outer posterior* gonopophyses, (G. 9, 2).

The *anterior gonopophyses* consist of a pair of blunt finger-like processes projecting caudad from the posterior edge of the pre-genital sternum and lying on either side of the penis, (G. 8). The bases of these gonopophyses are united with the chitinous edge of the pre-sternal plate, and are continued into the strong median *great apodeme* (Ap.), "inferior apophysis" of Gordon Hewitt, which runs cephalad ventral to the ejaculatory duct. The apodeme is also continuous with the theca or sheath of the penis, which together with the other processes forms an especially complicated heavily chitinized basal rim, by which apparently the penis is rotated or articulated. The shape of the great apodeme in the specimens examined by the writer is more paddle-like than "spoon-like," as described by Carpenter and Hewitt.

The Female Abdominal Segments.

The abdomen of the female may likewise be divided into two divisions, the preabdomen and the postabdomen.

The preabdomen is similar to that of the male. It consists of five segments, four of which, urites 2 to 5, are visible. The postabdomen, urites 6 to 10 or 11, is modified into a cylindrical tube which is called the ovipositor. The urites are joined together by means of long flexible intersegmental membrane or coria, making it possible for the segments to be telescoped in one another from behind forwards; the eighth, ninth and tenth into the seventh, the seventh into the sixth, and all then telescoped into the fifth.

The *Sixth Urite*, (6, Figs. 10, 11).—The tergite and sternite of the sixth segment differ but slightly from those described by Carpenter and Hewitt. The cephalic margin of the tergite in the specimens observed by the writer is not as completely rounded; the cephalo-lateral margin is concave and the union with the lateral margin is pointed rather than rounded. The sclerite is broader behind than in front. The sternite is broader in front than behind. Both the cephalic and caudal edges are emarginate.

The *Seventh Urite*, (7, Figs. 10, 11).—The seventh tergite consists of two slender elongate sclerites similar in shape to those figured by Carpenter and Hewitt. The sternite likewise consists of two slender sclerites more closely apposed than are the tergites, differing from Carpenter and Hewitt, who described only one sternal sclerite in *H. bovis*.

The *Eighth Urite*, much shorter than those preceding it, has two tergal sclerites, broad cephalad, pointed caudad and two long sinuate sternal sclerites. The caudal extremities of these sclerites are rounded and beset with short sharp spines, forming the ventral boundary of the tip of the ovipositor. (T. 8, St. 8, Figs. 12, 13).

The *Ninth Urite*.—The sclerites of this and the tenth segment have probably become fused, making it difficult to homologize them. Following Carpenter and Hewitt, I have designated the shield-like paired lateral sclerites the ninth sternites, (St. 9) and the proximal part of the last tergite, tergite nine. (T. 9, Fig. 14).

On the sides the tip of the ovipositor is bounded by a pair of blunt, curved, hooked-like sclerites. Each articulates with the caudal edge of sternite 9 and the lateral margin of tergite 9. Carpenter and Hewitt regard these sclerites as out-growths of the ninth segment and analogous to what I have designated the "styles" in the male, (P. 9). I agree with Carpenter and Hewitt that they are not cerci which are appendages of the eleventh segment.

The dorsal part of the tip of the ovipositor is bounded by tergite nine and ten. This sclerite is the largest of the sclerites forming the tip of the ovipositor. In its dorsal aspect, it is broad in front, tapering caudally to a narrow neck, then expanding. Its dorsal aspect reminds one somewhat of a tenpin. At its extremity this sclerite is directed ventrad, ending in a point. Together with the paired lateral sclerites (P. 9) and paired rounded ends of sternite 8, (P. 8), this sclerite surrounds the vulva opening beneath the eighth segment, and all five sclerites are joined by coria which is stretched when the egg is being laid. Then the tergal plate and lateral plates are directed dorsalward, the sternal plates remaining almost horizontal. The shoe or flange of the egg is directed dorsalwards. The writer has observed that *H. bovis* when laying eggs pushes the ovipositor almost vertically down among the hairs of the host, thus confirming Glaser's '13 observation. On the other hand, *H. lineata*, according to Glaser, holds its ovipositor nearly parallel to the skin of the host animal.

The caudal edge of each segment of the ovipositor is fringed with a circle of hairs, and the intersegmental cuticle between the sclerites has a beautiful reticulate black and white pattern, as pointed out by Carpenter and Hewitt. The intersegmental membrane is closely studded with curious short spines with broad bases and one, two, or three points each. The points are directed forwards when the ovipositor is extended. (Fig. 16).

The Female Reproductive Organs.

The Ovaries and Oviducts.—The ovaries of *H. bovis* (Fig. 19), present the characteristic tufted appearance observed by Carpenter and Hewitt. My specimens, however, being fixed in formalin did not permit the observation of the structure of the ovaries in detail as they report. Nevertheless, they seem to be of the same general structure. Each ovary is made up of many ovarioles. The ovarioles open, singly or by two, threes or fours into what may be termed secondary ovarian tubes,

which join together to form larger tubes, ultimately about 5 or 6 main ovarian tubes unite to form an oviduct. Each ovary in the specimens examined by the writer seemed to be made up of two distinct groups of ovarioles. The ducts leading from each join to form the oviducts. But this apparent difference from the structure of the ovaries described above might have been brought about by pressure in the abdomen of the female since the specimens were fixed in situ.

The egg in the ovariole is already surrounded by the shell with its grooved flange-like process for attachment to the host-animal's hair. Throughout its progress from the ovariole to the vulva the egg moves with this process directed caudally. The right and left oviducts leading respectively from the two ovaries, unite to form a common oviduct which merges into the vagina, (Fig. 17, Od.). The latter opens into the bursa copulatrix at the end of the ovipositor. The common oviduct and vagina form a subcylindrical tube nearly filling the cavity of the postabdominal segments. My specimens were fixed with the ovaries in situ, the ovipositor having first been extended. Upon dissection I found both the right and left ovaries and a portion of the right and left oviducts in the general abdominal cavity. The extreme tips of the ovaries reached nearly to the anterior end of the abdomen.

The *Spermatheca* (Fig. 17, 18 sp.).—Typical of the calypteræ, the spermatheca comprises three dark brown chitin-lined sacs each with a duct also chitin-lined opening close together in the mid-dorsal region of the vagina. The wall in the terminal portion of each duct is dilated slightly. Two of the spermatheca are located on the right of the oviduct and one on the left. On the walls of the spermatheca, transverse ridges and dark spots may be seen which, according to Carpenter and Hewitt, are chitinous ridges and small recurved hooks. The hooks are outside the chitin and in contact with the thin outer fibrous sheath of the spermatheca.

The *Accessory Glands* (colleterial glands), (Figs. 17, 18, A. G.)—One pair of long tubular accessory glands are found in *H. bovis*. They arise in the preabdominal cavity in the region of the ovarioles and open apparently into the distal portion of the vagina. They function probably in providing a cement-like secretion which serves to fasten the egg to the hair of the host.

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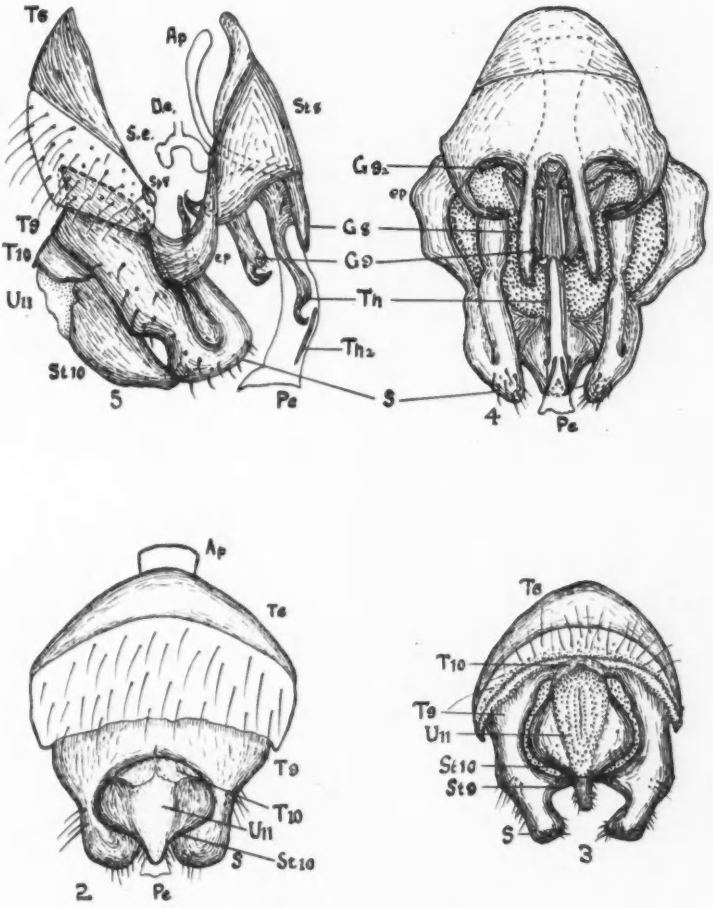


Hypoderma bovis, male, ×42.

Fig. 2. Dorsal aspect of postabdomen.
Fig. 3. Dorso-caudal view of postabdomen.
Fig. 4. Ventral view of postabdomen.
Fig. 5. Lateral view of postabdomen.

Explanation of Lettering: T6, tergite 6; T9, tergite 9; T10, tergite 10; U11, urite 11; St10, sternite 10; S, styles; ep. epipleuron; Sp8, spiracle 8; S.e., ejaculatory sac; D.e., ejaculatory duct; Ap., great apodeme; St8, sternite 8; G8, anterior gonopophyses; G9, posterior gonopaphyses; $G9_2$, outer-posterior gonopophyses; Th, theca or juxta; Th_2, theca.

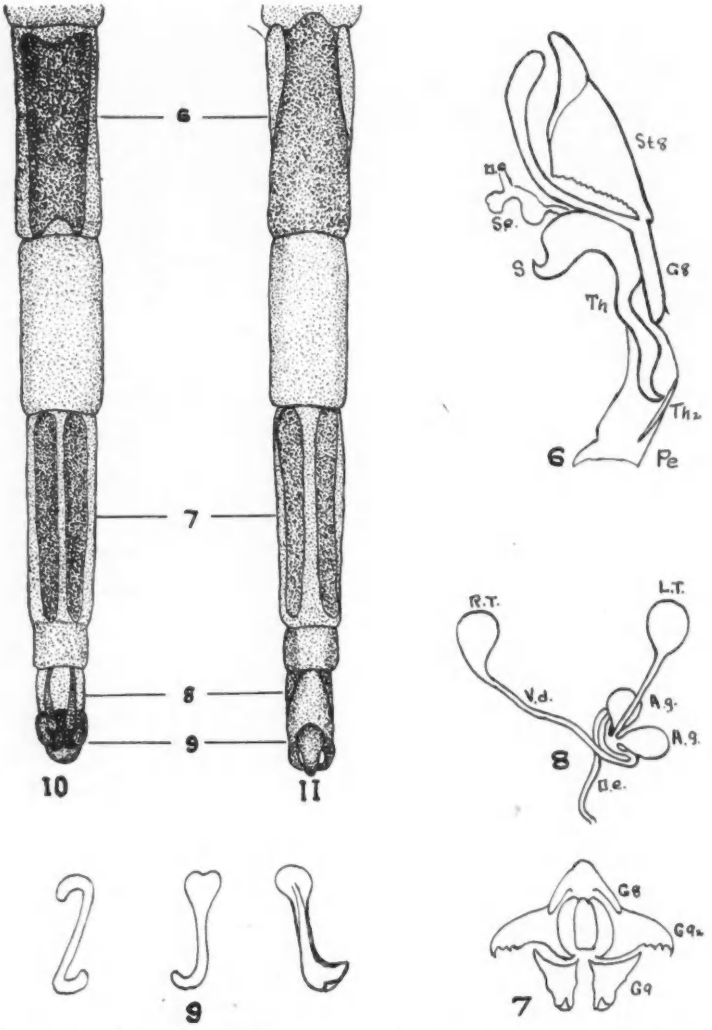


Fig. 6. Penis and Associated Structures. S, median spine of theca. . ×40.
Fig. 7. Gonopophyses, caudo-ventral view.
Fig. 8. Male Reproductive Organs. ×6 R. T., right testis; L. T., left testis; V. d., vas deferens; A. g., accessory glands; D. e., ejaculatory duct.
Fig. 9. Various view of the chitinous support of the ejaculatory sac. ×50.
Fig. 10. Ovipositor, ventral view. ×10.
Fig. 11. Ovipositor, dorsal view. ×10.

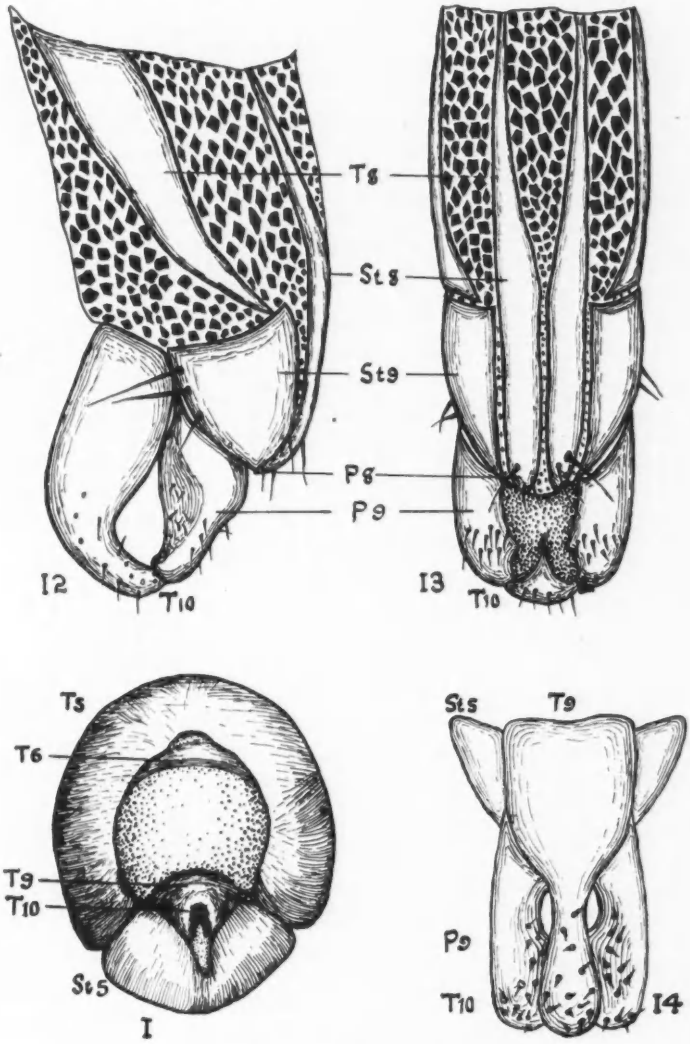


Fig. 1. Caudal aspect of the abdomen of the male. ×14.
Fig. 12. Terminal segments of the ovipositor, lateral view. ×80.
Fig. 13. Same, ventral view. ×80.
Fig. 14. Tip of ovipositor, dorsal view. ×80.

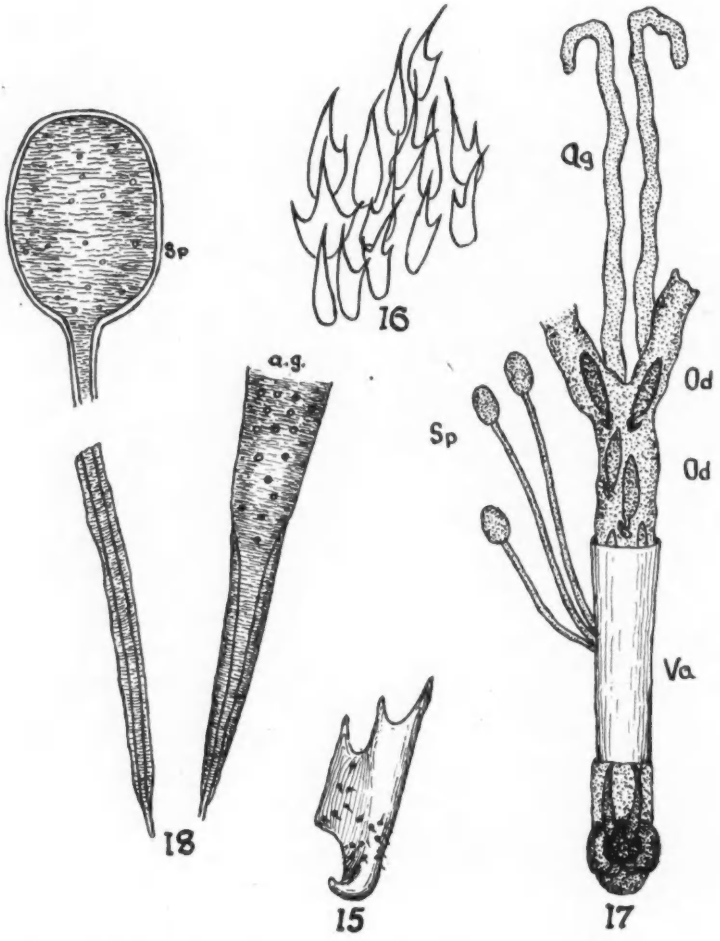


Fig. 15. Lateral view of gonopophyses. P 9. ×80.
Fig. 16. Spines of the intersegmental membrane. ×300.
Fig. 17. Female reproductive organs. ×10. Ag, accessory glands; Od, oviduct; Sp. spermatheca; Va, vagina.
Fig. 18. Spermatheca and accessory gland. ×50.

NEW GENERA AND SUBGENERA FROM THE GENUS DELTOCEPHALUS.

A Study of the Internal Male Genitalia of the American Species and Their Bearing Upon Taxonomy.*

D. M. DeLong and J. P. Sleesman,
Department of Entomology, Ohio State University.

Some two years ago the senior author constructed and published a key to the North American species of Deltocephalus,† using external characters in an attempt to form a working basis for this group. During this study several problems in taxonomy and relationship presented themselves and had to remain unsolved for the time without an examination and detailed comparative study of internal characters. The present treatment, discussion and figures, is an attempt to throw more light upon these relationships by presenting the structures and data which will assist in solving some of these problems and establishing certain taxonomic relationships among these species.

On the basis of characters used in the previous treatment the genus was divided into a number of subgenera. For this division, wing, head and external genital characters were used. One of the problems in mind in the present study and treatment was a critical study of these divisions which were made formerly. It would seem from the evidence at hand that this division into groups was correct as far as they were established, but that still others should be set off because of certain unique characters, or groups of characters.

Another phase of the generic problem has also entered this discussion, that is the relationship of long established genera which are closely related to the genus *Deltocephalus* as it was formerly recognized, to the different subgenera as set off recently by the senior author. It is apparent from previous and present study that certain genera like *Thamnotettix*, *Euscelis*, *Lontura*, and others of this general group are more

*Contribution No. 94 from the Department of Zoology and Entomology, Ohio State University.

†Ohio State University Bulletin, Vol. II, No. 13, January 15, 1926.

closely related to certain of these subgenera than some of the subgenera are to each other, especially the extreme groups. It seems logical therefore to term these groups genera in the future and they are thus treated in the following discussion. Also two new genera and two subgenera are established. For many years species that could not be disposed of otherwise were placed in the genus *Deltocephalus* and it is time that these were separated into their proper groups.

There remains little doubt concerning the question of where to place the species recently known as *Thamnotettix nigrifrons* Forbes which was separated from its apparent close relatives because of the absence of a second cross vein in the wing. This small group of *Thamnotettix* belongs with the subgroup carrying the *Deltocephalus* name and containing such species as *vanduzei*, *balli* and *fuscinervosus*. Furthermore, certain *Thamnotettix* species, like *inornatus*, are undoubtedly closely related to the *Laevicephalus* group, while several species of *Euscelis* and *Lonatura* are closely related to species of the *Amplicephalus* group.

Genus **Flexamius** De Long.

(Plates I, II and III).

The genus *Flexamius* was erected by the senior author and this division was based largely upon the character presented by the reflexed costal veins of the first pair of wings. Several rather distinct subgroups were noticed in this subgenus showing diverse types of genitalia which were illustrated previously. In the former treatment these were placed together since external structures alone were considered of necessity. As might be expected when establishing a group chiefly upon a wing character, great diversity is found in the structure of the internal genitalia throughout this group upon examination of these structures. In several cases this is so marked that doubt arises concerning the placing of certain of these species in the same subgenus and even their probable separation into more diverse grouping. At the same time this condition may be due to a loss of or our inability to locate intermediate forms.

The styles probably show less variation than the other internal structures, but in most cases these show specific differences. The terminal processes exhibit the greatest specific

variations regarding size, length and curvature. In some species a spine-like process is present on the anterior lateral corner. The articulation with the connectives also presents slight specific differences. In a lateral view the lateral dorsal folding of the styles is rather prominent in most species. *Abbreviatus* and *surculus*, with their wide blunt apices with angled margins, are quite different from the more pointed apices of the other species of the group as regards the styles.

The oedagus varies greatly throughout the group, especially as regards the terminal processes and is probably the best internal character for specific separation as well as showing those species which are more closely related. The body of the oedagus may be long or short, rather even in width throughout its length or tapering from anterior to posterior ends. The terminal processes may be two in number, same size and type, three in number different size and type, and either single or bifurcate.

From this study some of the more interesting relationships might be pointed out, as well as some of the unique and striking differences. The study would indicate that there have been certain developments in different directions from a generalized type, and these groups which have developed in different ways seem to contain certain species more closely related to each other than to the other species.

Pectinatus appears to be of this generalized type. The oedagus is simple in form and devoid of terminal processes. *Abbreviatus* appears to be rather closely related to *pectinatus*, the oedagus being of the same type but somewhat heavier. The styles of this species on the other hand with the wide blunt apices are different and unique for the group with the exception of *surculus*. It is doubtful where this latter species should be placed, but it shows evidence of being closely related to *abbreviatus*. The styles and bifurcate anterior processes of the oedagus of *surculus* are of the same general type, although the bifurcate terminal processes are similar to those of the *albidus* group.

Four of the species examined, *pictus*, *pyrops*, *sandersi* and *visendus*, each have a pair of terminal processes on the oedagus and are different in this respect from the other species discussed here. *Pyrops* and *pictus* are very similar in view of the pair of tapering terminal processes on each, and their anterior

dorsal processes of the oedagus. *Pyrops* seems to be only an extreme form of this type of oedagus structure. The styles are different in shape and are proportionately larger in the case of *pyrops*. The pygofers of pictus in the region just dorsal to the plates are drawn out into long, triangular, pointed structures which overlap. The other two species examined with two terminal processes, *sandersi* and *visendus*, are quite similar in structure and have been confused because of their external resemblance. The terminal processes of the oedagus are of the same general type and armed with barbed processes, but are distinct. In *visendus* these processes are much longer and broader. The styles are almost identical. The anterior processes of the oedagus are distinct, being hooked or bent at right angles in the case of *sandersi* and straight in *visendus*. One of the best specific characters is found in the pygofers since in *visendus* the edges are serrated and overlap in the region just dorsal to the plates, which condition is not found in *sandersi*.

Specimens of *stylatus* have not been available for dissection, but the styles are so long in this species that they are visible without dissecting. They are long, black and conspicuous, exceeding the blunt plates. This character as shown in Ohio State University Bulletin, Vol. II, No. 13, Plate IX, 5b, is an excellent one for external use.

Inflatus, *flexulosus* and *areolatus* show another diversion in having three terminal processes on the oedagus. In *flexulosus* the three processes are short and of the same type and size, while in *inflatus* two are of the same size and type, lateral in position and resembling somewhat the two processed species, but the third is of different type and much longer. The extreme of the three terminal processed character is apparently reached in *areolatus*, where one process is longer and appears heavily clothed with coarse pubescence, while the shorter two are smooth. The styles are very similar to the other species like *sandersi*. In *slossoni* and *albidus* the pair of bifurcate terminal processes of the oedagus shows some similarity, but not necessarily close relationship since other characters are quite different. In *slossoni* the body of the oedagus attains its greatest width in the middle while in *albidus* the oeadgus is wide at the ends and narrow in the middle. The anterior processes of the oedagus in *albidus* are distinct, their caudal

extremities being expanded into wide bulb-like structures. The styles are different specifically. Furthermore in *slossoni* the terminal fourth of the oedagus curves ventrally and anteriorly, terminating in a rather sharp point. This condition is unique among those species of *Flexamius* examined. A sharp spine-like process which is also unique is found on the ventral side of the oedagus posterior to the articulation with the connectives. In view of these characters and the wing condition a new subgenus is described here and *slossoni* is placed as the type of this group.

Subgenus **Secopennis** nov.

(Plates II and III).

Head produced and flat as in *Flexamius*. Elytra broad and flaring venation somewhat similar to *Flexamius* with the reflexed costal veins present but with posterior margin of elytra sloping obliquely from the claval vein and slightly concavely rounded to the costal margin forming a produced portion on the costal margin which is rounded at the apex. The inner apical cells are very short as seen in the figure of this venation which is given in the monograph of Deltocephalus Plate IV for *slossoni*. This sepcies is designated as the type of this subgenus.

The species is so different from the *Flexamius* group that it has seemed advisable with further study to place it in a separate subgenus.

Subgenus **Palus** nov.

(Plate IV).

Elytra with a definite but small appendix, central ante-apical cell constricted at center but not divided, outer ante-apical cell quite small, sometimes almost obsolete, two or three costal veins slightly reflexed. Vertex somewhat variable in length and degree of angle. Margin of vetex not sharply defined as in *Flexamius*. The external genital characters of the four known species of this group are very similar in both the males and females.

All of these species live on sedges or coarse grasses of the fresh water marshes and all occur in northern habitats.

Type of subgenus *delector*.

The males of only one species have been available in sufficient numbers for dissection.

In *delector* the only species of this apparently diverse group which was available or sufficiently abundant for dissection,

these structures show still further differences. In general form the styles are not greatly different from the generalized type. The oedagus from a lateral view is narrow at the base soon enlarging abruptly dorsally at the top of which a pair of long spine-like processes extend ventrally one either side to the ventral side of the oedagus. Although heavily chitinized on only the ventral side, the oedagus is thickened to the posterior end, tapering slightly to a bluntly pointed tip. A slight spur extends dorsally near the tip. In dorsal view the oedagus is slightly constricted on the central half, the most unique portion being the apex, which is enlarged, with a pair of diverse pointed tips, a pair of barb like spines extending anteriorly at the anterior point of enlargement. This group is apparently quite different from the preceding ones mentioned if we may judge from this species which externally resembles very closely the others which are placed here.

Genus **Alapus** nov.

(Plates II and III).

Vertex similar to *Flexamius* but more strongly produced, usually almost twice as long as width between eyes. Elytra with several cross veins in clavus and middle anteapical cell usually divided into three or more cells. Male pygophers with flapper like structures attached to posterior margin inside of genital chamber and extending forward when in normal position.

Fraternus and *mendosus*, which differ markedly from the *Flexamius* group in the characters mentioned above, as well as the strikingly different external genital characters, are placed in this genus. *Fraternus* is designated as the type.

The internal genitalia although very similar in these two forms seems to give slight specific differences.

Mendosus and *fraternus* have been commonly confused and if species, they are undoubtedly very closely related. The oedagus, although similar and variable in both species, seems to be distinct, It is rather short and comparatively broad, not tapering, terminating very bluntly. At about the middle a pair of wing-like processes are given off which from a side view are continuous dorsally. From a ventral view the oedagus appears to rest on a bifurcate structure which is attached to the wing-like structures anteriorly, apparently without a direct connection. The two processes of this bifurcate structure are

directed posteriorly curving inward, extending as far as the anal ring, to which they are usually attached by the surrounding membrane. These processes present the only constant specific differences, in *mendosus* they are heavier and broader than in *fraternus*, but not as long. From a side view the processes in *mendosus* make an abrupt bend dorsally at about the middle, while in *fraternus* they curve or slope gradually. The styles of these two species are different from the other species of the subgenus, but they are very similar to each other. A considerable amount of variation especially in regard to the width and curvature of the terminal processes and their apices was found among the specimens of these two species examined. In *mendosus* the styles extend beyond the plates.

A pair of structures are present in each of these two species which have not been found elsewhere in the group. They are long tapering, flapper-like structures appearing netted and attached to the posterior part of the pygofers near the median line. From this point of attachment the free end extends anteriorly more than half the length of the pygofer. Occasionally they are found extending posteriorly outside the genital chamber. The external characters of the plates which might be used to separate these species have already been mentioned previously by the senior author. After studying a number of specimens of *mendosus* and *fraternus*, the only constant internal structures found are the oedagi, which are similar except for the bifurcate structures. The processes of these seem to be constant specific characters at least for the material studied.

These two species or species in the making should probably be given generic or subgeneric ranking, since internal and external structures both would indicate a rather distinct type of insect. They are therefore referred to a separate group as indicated here.

Genus **Latalus** nov.

(Plates II and III).

Vertex angularly produced, but usually not greatly longer than width between eyes. Reflexed arcs of front not visible from above Elytra with short veinlets meeting costa at about right angles but differs from *Flexamius* in having no reflexed veinlets to costa. Elytra usually short just covering abdomen. Type of genus *sayi*.

The senior author has mentioned previously that this group is quite different from the species of *Flexamius* and it has seemed advisable to separate it because of further evidence obtained during this study.

Four species of this group are found in sufficient numbers so that specimens were obtained for a study of internal characters.

In external structures and general appearance *misellus*, *ocellaris* and *sayi* appear very closely related externally. The plates, pygofers and valves would indicate close relationship. An examination of the internal characters shows a great difference in structures. The oedagus is quite variable. In *misellus* the oedagus in ventral view appears very short, but a lateral view shows it to be long but directed dorsally and anteriorly. A pair of spine-like structures are found near the base of the terminal portion, while the dorsal portion is pointed. There are no anterior dorsal processes. The oedagus of *sayi* is very broad at the base, with two short lateral dorsal processes. The central portion is constricted and the terminal portion again broadened into two wing-like structures from between which a pair of long slender processes arise extending ventrally and anteriorly. In *ocellaris* the oedagus is comparatively narrow, the base being expanded and triangular in shape. Four terminal processes are visible, two of these are long and slender, directed anteriorly, two others are short and hair-like, directed posteriorly. The dorsal process of the oedagus seems most closely related to *sayi*.

Configuratus is apparently related to the *sayi-ocellaris* group, the oedagus being of the same general type. The oedagus of *configuratus* is broad at the base and the terminal one-fifth is split. In lateral view it shows similarity in its makeup to these other species. The styles are similar to *ocellaris* and *sayi*.

Genus **Polyamius** De Long.

(Plates IV and IX).

This subgenus was also erected by using primarily a wing character in the form of the cross veins of the clavus, as an important character. In this group we find a great similarity of external genitalia. The group thus seems to contain species

rather closely related to each other if we may judge from the similarity of internal genital characters as well as the external structures, and if the species examined are typical of the remaining unexamined and unavailable species.

The styles of the species throughout the group show great similarity, although specific in practically all of the species. The general shape and form, however, is very similar except in regard to minor details. In *obtectus* for instance the styles have very long anterior inner processes. In species like *arundineus* and *apicatus* these are of average length, while in species like *inimicus* and *texanus* these processes are very short.

The oedagus displays characters which are more varied and characteristic for the species of this group. What might be designated as a generalized type is represented by four of the species which were examined, namely, *apicatus*, *compactus*, *caperatus*, and *interruptus*. These four species have oedagi which are very similar. From a ventral view the oedagus in each of these species is enlarged at the middle, tapering anteriorly rather rapidly to an apex which is bluntly rounded, and posteriorly rather gradually to a bluntly pointed apex. In lateral view in each case the oedagus is enlarged in the central half and bears an anterior dorsal process extending slightly posteriorly and connected with the anal ring by a membraneous structure. The posterior end of the oedagus is narrowed and curves dorsally. There is a specific difference shown in this character as the size and comparative length of this portion is characteristic for each species examined. *Caperatus* and *interruptus* exhibit the longer terminal portions, while *apicatus* and *compactus* display the shorter terminal processes.

From this generalized type the other species examined might easily have developed but along diverse lines. *Obtectus* for instance, which resembles *compactus* so closely in external appearance, might easily have developed from this type. In lateral view the oedagus is strikingly similar, but is tapered more gradually to the posterior end. In ventral view the oedagus is seen to be broader and more broadly rounded posteriorly, bearing a U-shaped notch at the apex.

The *weedi*, *texanus*, *micarius* group might also have arisen from a generalized form of this kind and since they resemble *interruptus* very strongly superficially this probably indicates the source or stem of such a development. The oedagus of

weedi in ventral view is not greatly different from *interruptus* except that it shows a bifurcate condition at the apex. In lateral view it is similar in that the terminal portion is narrowed, curved dorsally and even curves anteriorly in this particular case. It is quite different, however, since there is no anterior dorsal process, and since it is provided with an additional ventral posterior portion formed by the apparent division of the posterior half.

Texanus resembles *weedi* so closely in regard to color, size and form that they cannot be separated without examining the external genital characters. Upon examining the internal structures we find *texanus* is unique among these species especially in regard to the oedagus. From a ventral view the oedagus appears broader for a longer distance from the base, then narrows abruptly to a slender bifurcate apex. In a lateral view the oedagus appears entirely different from *weedi* but has the same number of parts which differ proportionately. The dorsal process is short and straight, flattened above. The ventral portion is longer and heavier, bent at right angles and extending dorsally with a bifurcate apex.

Micarius may have arisen independently of these two species, but it shows some similarity both externally and internally. The oedagus is not enlarged at the middle laterally, but is of about a uniform size and is slightly constricted near the apex. At the base is a short dorsal process and on the connective is found a pair of short dorsal spines. From a ventral view the oedagus is broad, slightly wider at the middle with a pair of teeth-like structures, one either side of a central rounded notch. *Micarius* apparently has come from this generalized type and is still very close to it in many respects.

The most common species of the genus *inimicus*, is very similar in the structure of the internal genitalia to the four species mentioned first. The oedagus in ventral view is long and broad with a broadly rounded apex. In lateral view it is broad at the base with a rather long dorsal process extending slightly anteriorly. The posterior half of the oedagus is narrowed, curved upward and terminates in a rather pointed apex.

Another species, *montanus*, described elsewhere as new, is known only from Montana and superficially resembles *inimicus* very closely. The internal genitalia also show similarity.

The styles are decidedly longer and more narrowed, with a different apex as shown by the figures, Plate IX. The lateral view of the oedagus also shows distinct differences. In *montanus* the oedagus is longer and more narrowed than *inimicus* and although similar as regards the general structure, it is distinct. The apical portion of the pygofer also is entirely different in the two species.

Arundineus shows more divergence than any of the other species, but the oedagus in lateral view shows some similarity to the generalized form. The dorsal process is present and in addition there are two dorso-lateral processes which extend posteriorly. The body of the oedagus gradually narrows to a slender pointed apex. In ventral view the oedagus appears somewhat complicated and confused. The body is broad at the base, but rapidly narrows, then slightly enlarges again just before the bifurcate apex. The dorsal process is broad and blunt at the apex. The dorso-lateral processes arise not far from the base and extend posteriorly, curving inwardly. The tips are pointed and each one is notched on the outer edge, giving it a barbed appearance.

Genus **Hebecephalus** De Long.

(Plates VI and VIII).

A head character was used as a basis for establishing this group. The vertex is usually bluntly angled and the front margin of the vertex is usually quite thick and bluntly angled with the front. The internal male characters indicate a rather close relationship of the species examined.

Three species have been available in sufficient numbers for an examination of the internal male structures. The styles are of the same general type although quite diverse specifically. In *signatifrons* there is a very deep indented portion near the tip forming a rather narrow sharply curved terminal portion. *Vinculatus* is definitely constricted at about half its length and is slightly indented at the tip. The apex is turned backward, prolonged, tapered and sharply angled. *Cruciatus* is only slightly curved at the apex because of a broad shallow notch. The oedagi are quite different in form also. In lateral view the oedagi of *vinculatus* and *cruciatus* are more similar, but in ventral view *vinculatus* shows more similarity to *signatifrons*.

In lateral view the oedagus of *cruciatus* is enlarged at the base, while *vinculatus* is scarcely larger in size basally. Both of these species have a basal spur directed dorsally and apically. In *signatifrons* the basal spur is directed dorsally and slightly anteriorly. The apical portion is longer than in either of the other species and is armed with two reflex spine-like structures at the tip which are quite long. In ventral view the oedagus of *signatifrons* is narrowed medially and the apical lateral spine-like processes are very conspicuous. The dorsal processes are conspicuous at the sides of the oedagus at the base. *Vinculatus* differs from *signatifrons* in having the lateral terminal processes much shorter and the oedagus not greatly widened at the base. *Cruciatus*, although widened at the base, does not bear lateral processes.

These characters are good specifically and yet tend to show a rather close relationship between these species examined.

Genus **Laevicephalus** De Long.

(Plates V, VI and VIII).

This group was established on the basis of a vertex which is angularly produced and with a flat discal portion. The vertex may be sharply, acutely or rather bluntly angled. This group is closely related to the species of *Thamnotettix* of the *inornatus* group and the wing venation is quite similar to the species of that group except for the two cross veins in the discal portion.

This genus contains a number of species which are very similar in appearance and with external genital characters quite similar in many instances although these external characters are usually specific and sufficient in most cases to separate them. There is a decided absence of color markings throughout this group. In view of these facts it is frequently considered that certain of these species are more closely related to each other than seems to be indicated by an examination of the internal genital structures. The type of head and other similar external structures are usually good characters to show relationships also.

When we examine the internal male structures we find on first examination what appears to be quite diverse structures, but after making a thorough study of these it is evident that certain relationships exist among these species.

An examination of the styles shows a great variation as represented by the different species. Most of these species have styles which might be placed in one of two general classes. The first group might be designated as a type with the terminal end usually squarely cut and blunt. The species of the second group have the terminal ends pointed and frequently an incised or indented portion which helps to form the terminal curved spur.

In the first group *acus* and *sylvestris* show close relationship having styles that are very similar. The base of each is broad and the terminal portion narrowed. Others of this group which show this character are *melsheimerii*, *debilis*, *spicatus*, *collinus*, *cinerosus* and *unicoloratus*. *Melshemerii* and *debilis* have very similar styles with a constricted portion just before the blunt apex. *Unicoloratus*, although narrow at the base, is not greatly different from *acus* and *sylvestris*. *Spicatus*, *collinus* and *cinerosus*, although appearing similar because of their narrow basal portions, are each quite different from the others and unique when studied in detail. *Cinerosus* is slightly constricted near the apex and the basal portion is greatly curved and thus folded, which causes it to appear narrow. *Collinus* is broadened at the base and the basal portion appears the most narrowed because of the curved condition.

In the second group there is a great variation in the type of styles, especially in regard to indentation or constriction near the apex. *Striatus* is only slightly constricted near the apex, but the inner basal angle is greatly produced into a long narrow process extending to the connectives. *Abdominalis* has a style which is long and narrow and tapered to a pointed apex. The basal portion is tapered off on one side, but is prolonged on the other and folded back upon itself in such a way as to appear broad. *Auratus* is rather unique also since it is broad basally and apically and is constricted at the middle. The apical portion is pointed and is broadly curved to another pointed lateral portion. Another species which has a unique style is *littoralis*. It is as broad as long and the apical portion is abruptly narrowed to form a pointed apex. The outer basal portion is broad and greatly produced laterally. The generalized type of style is found in the case of *cicatrix*, *orbiculus*, *bimaculatus*, *subrutilus*, and *flavovirens*. *Cicatrix* and *orbiculus* show the rather deep indented apical portion with a curved,

sharply pointed apex. The basal portion is broad and the central portion constricted. *Subrutilus* and *bimaculatus* show a less indented condition near the apex. The broad basal condition is found in *subrutilus*, but in *bimaculatus* the basal portion is narrowed and rather pointed. The style of *parvulus* is gradually narrowed apically and is not indented. *Pascuellus* is of the same general type as regards the style, although only slightly indented apically and bluntly pointed.

These structures present good specific characters for the separation of these species in practically every case as contrasted with those subgenera where the styles are almost identical. These structures are therefore valuable for evidence of specificity and for the separation of species which are superficially so similar that they have been confused for many years.

The oedagi are even more diverse in character and more valuable in showing relationships and in forming evidence for specificity. If one should glance at the oedagi of these species as shown in either lateral or ventral view, he probably would see very little similarity between different species represented in this subgenus. A careful study of these species, however, shows rather definite similarities in structure.

The most simple type of oedagus and probably the most generalized type is found in *spicatus* and *debilis*. The latter species shows a small dorsal spur-like structure at the basal end, which character is quite common to the species of this genus. This structure is absent in *spicatus*. With slight modification it is easy to note the similarity between this type of oedagus and the type we see represented in a number of closely related species such as *orbiculus*, *subrutilus*, *melshemeri*, *parvulus*, *acus*, *sylvestris*, *unicoloratus* and *littoralis*. If we compare these in lateral view, Plate VIII, it is easy to make a relative comparison of these oedagi. *Orbiculus* and *subrutilus* are very similar to *debilis*, except that the dorsal spur is rather long in both cases and a pair of long lateral processes are found at the end of the apical portion of the oedagus in *subrutilus*, *melshemeri* and *parvulus* show further modifications. *Melshemeri* possesses a broad basal portion and the apical structure is rather long and slender. In *parvulus* the basal portion is missing and the dorsal process is much longer and directed apically. *Acus* and *sylvestris* are very closely related to each other and both show a further development of the oedagus especially in

length. The oedagus is extremely long and narrow, somewhat bent and slightly hooked at the apex. The most pronounced difference in the character of the oedagus in these two species is the distinctly longer dorsal spur in the case of *sylvestris*. *Unicoloratus* is not greatly different from *acus* and *sylvestris* and shows a rather close relationship to these species. The oedagus has a short spur at the base and a minute spine on the ventral side not far from the apex. The oedagus of *littoralis* is shorter and broader with a rather large spur extending dorsally.

Another group of three species, although distinct and differing considerably from each other, show a further development in the oedagus. Each of these has a pair or more of terminal processes and the oedagus in each case is strongly curved or looped basally so that the terminal portion of the oedagus extends almost dorsally. In *abdominalis* the oedagus is not enlarged and both basally and apically extends strongly dorsally with a pair of distinct apical processes. *Cicatrix* is enlarged basally with a short anterior dorsal process and a long apical dorsal process. The latter is set with two proximal pairs of anterior apical spine-like processes. If *flavovirens* is a "*Deltocephalus*" it probably is most closely related to this group. The oedagus of this species is somewhat similar to the former two. It is also enlarged basally and has a pair of terminal processes. There is some question too regarding the relative position of *bimaculatus*, which may not belong to this subgenus. The oedagus does not show strong similarity to any other of these species, but is probably most closely related to forms like *debilis* and *cicatrix*. *Collinus* and *cinerosus* are two species which have oedagi of a different type. They are similar only in view of the fact that they each have an oedagus with a pair of short basal processes and with a pair of terminal processes. They probably are not closely related. *Collinus* has an enlarged basal portion with a dorsal process, a pair of short lateral processes are found at the apex. In *cinerosus* the basal portion is not enlarged, but is directed dorsally then curves and extends apically and possesses a pair of rather long lateral processes near the apex which are directed backwards.

Two other species, *striatus* and *pascuellus*, have oedagi which are different from any others of the group. In *striatus* the oedagus seems to be turned upside down in lateral view with an anterior process extending ventrally in this case and the

oedagus is directed anteriorly and curves ventrally. In ventral view it is short and very broad. *Pascuellus* has an oedagus which curves back upon itself so that the apical half extends anteriorly. The most unique oedagus of the group is probably found in *auratus*. In this case the oedagus has a central portion with the dorsal terminal part enlarged. From the base a pair of long curved processes extend, on either side, past the apex of the terminal process of the central portion. Although superficially this species resembles *subrutilus* very closely and they have been placed under the same name for many years, there is no similarity of the structures of their oedagi.

The style-oedagus connectives show very good characters also, but it is not necessary to go into a detailed discussion of these. It might be advisable to simply point out the more important types and differences. Certain forms like *bimaculatus*, *parvulus*, *unicoloratus* and *collinus* have very short connectives. On the other hand species like *striatus* and *debilis* may have very long connectives. A comparison of the ventral view of these structures as seen in Plate VIII, will give a good idea of their variation among the different species.

Genus **Amplicephalus** De Long.

(Plates VII and VIII).

This genus was established chiefly upon the basis of the broad head character and three species have been placed in the genus to date. Two of these, *osborni* and *simplex*, have been available in sufficient numbers for dissection and a study of the genitalia. One of these, *osborni*, is a member of the freshwater marsh association, and the other, *simplex*, lives in the salt marsh association upon *Spartina patens*. The styles of these two species differ considerably. In *simplex* the style is broadest at the base and tapers to the apex, while in *osborni* the broadest portion is at the middle and the apical portion is comparatively longer. The oedagi are quite similar especially in lateral view, where the chief differences seem to be the shape of the terminal portion and the position and direction of the basal dorsal spur. In dorsal view the oedagus of *simplex* is much longer and tapered to a bifurcate tip. In *osborni* the tip is not greatly narrowed and a rather deep concavity is between the outer apices.

This group shows some similarity to both *Laevicephalus* and *Deltocephalus* species and is apparently closely related to certain groups now included in the genus *Euscelis*.

Genus **Deltocephalus** Burmeister.

(Plates VII and VIII).

In view of the fact that *pulicarius* was formerly chosen as the type of the genus it has been necessary to give this group the name of the original genus. This type was chosen by Oshanin and not by Van Duzee, as previously stated by the senior author. The vertex is short, bluntly angled and with disc sloping or convexly rounding from pronotum to the front. Margin of vertex usually very thick. The head character is again the one upon which emphasis was placed in establishing the group. The external genitalia are very similar, however, in the species throughout this group.

The examination of the external structures of the species of this subgenus would lead one to believe that these species are very closely related. In fact in a few cases there has been some question as to the specificity of certain forms. An examination of the internal genitalia has led to the same general conclusion, namely, that these species are a group of very closely related forms, although the internal characters indicate sufficient differences in structure to separate them quite easily.

An examination and study of the styles shows two rather distinct types to which most of the species belong. In one of these groups we might place *balli*, *minutus*, *vanduzei*, *pulicarius* and *castoreus*. These all contain relatively long sharp pointed terminal processes, although their relative width, the angular incision at the base of this process and the basal processes differ considerably. Of this group *pulicarius* and *castoreus* are quite similar, both lacking the deep curvature on the basal portion and the long pieces which articulate with the connectives; *balli* and *vanduzei* are of this later type. *Minutus* presents a somewhat different type with no indication of an articulation process, the basal portion curving from the outer lateral angle to the inner margin. *Flavicostatus* is quite similar to *minutus* in its general structure, but has a very peculiar and different process produced on its inner basal portion as an articulation process. One other species, *nigriventer*, possesses an extremely

long process and the shape of the style in general is entirely different from any other species that has been examined. A second group of species, including *nigrifrons*, *fuscinervosus*, *sonorus* and *marinus*, have rather short terminal processes. Otherwise they are somewhat variable especially in regard to slight differences in the basal structures. *Fuscinervosus* shows the greatest difference in the terminal process, since it is broader and more decidedly curved laterally. *Comesus*, a species described elsewhere, seems entirely different from these other species just considered and has a style which is gradually tapered to a blunt, rounded terminal portion.

An examination of the oedagi in side view shows that with the exception of two or three species the members of this subgenus are very similar in general type. This general type of oedagus is seen especially in *balli*, *pulicarius*, *comesus*, *sonorus*, *castoreus*, *vanduzei*, *nigrifrons* and *fuscinervosus*. Each of these oedagi has an anterior dorsal process directed slightly caudally although the curvature or comparative length of the apical portion may vary slightly. A few species like *minutus* and *nigriventer* have this process directed almost anteriorly. *Nigriventer* presents other differences also in the body of the oedagus especially the anterior ventral portion. The oedagus of *marinus* has the anterior dorsal process, but the body of the oedagus is broad and heavy, appearing inflated and does not have the apical dorsally curved portion characteristic of these other species. *Flavicostatus* is also somewhat different, although it undoubtedly shows its relationship to this group. The apical portion of the oedagus is proportionately heavier, longer and directed more decidedly dorsally and slightly anteriorly. Specimens examined from various portions of South, Central, and North America would indicate that the North American forms, especially north of Mexico, are probably different as Mr. Van Duzee previously suggested and should be properly called *flavicosta*. The oedagus, as the accompanying figures, Plate VIII, will indicate, is more narrowed than, and is somewhat different in shape from *flavicostatus*.

In ventral view the oedagi show some specific and in a few cases unique, differences. *Marinus*, in view of the deeply cleft broad terminal portion, is entirely different from all the others. Species like *balli*, *nigrifrons*, *vanduzei*, *fuscinervosus*, *pulicarius*, *sonorus*, *minutus*, *castoreus* and *comesus* have oedagi

that are quite similar in ventral view. But the comparative length or widened portions of these structures are apparently specific as in the case of *balli*, for instance, which is decidedly widened a little from the base, or *nigrifrons*, which is decidedly longer, as well as forms like *fuscinervosus* and *comesus*, which are apically enlarged or have apical processes. *Nigriventer* with its basal processes and pointed apex and *flavicostatus* with its broad rounded base and tapered apex are easily distinguished from the other species. In this group the connectives present a group of good characters also. Those of *flavicostatus* are unique, also different types are found in each of such species as *minutus*, *nigriventer*, *marinus* and *vanduzei*.

There seems to be no question concerning the relationship between this group and certain species which have been included in the genus *Thamnotettix*. *Th. nigrifrons* and closely related forms have presented for some time a question upon generic status concerning which authorities have disagreed. The wing venation character upon which these were separated into different genera apparently must be superceded by the genital character in such cases which is apparently a better index to relationship. With *pulicarius* as the type of the genus *Deltocephalus* there is only one disposition to make in the case of *nigrifrons* and that is to place it in the same genus because of its great similarity.

The following new species have been described during this study:

Flexamius surculus n. sp.

(Plates I and III).

Resembling *abbreviatus* very closely in form and appearance but with internal genitalia of the male and external genitalia of both sexes distinct. Length 3–3½ mm.

Vertex bluntly angled, almost one third longer at middle than width between eyes. Elytra short, scarcely covering abdomen.

Color: Very similar to *abbreviatus* and other closely related forms. Vertex with the dark brown circular mark around apex, the lines above margin of vertex, the transverse dashes on the disc and the longitudinal markings at the base present. Elytra varying in intensity of color but usually with a spot along outer claval vein, basal portion of the discal cell and a large spot on outer apical cell dark brown. Infuscation of veins on apical portion of elytra rather heavy.

Genitalia: Female last ventral segment with the posterior margin produced to form an angular lobe either side of the central two-thirds

which is rather deeply emarginate either side of a slightly produced central portion, heavily embrowned and composed of four teeth, two outer teeth sharp, narrow and more produced than the inner pair which are broader and more bluntly rounded. The outer teeth are separated from the inner pair by rather deep rounded notches. The inner pair are separated from each other by a rather broad V-shaped notch. Male valve broad, triangular. Plates exceeding valve by about its length, gradually tapering to about two-thirds their length where they are abruptly emarginate and narrowed to form the apical portions which are blunt and rounded to their inner margins. Pygophers greatly exceeding plates.

Described from a series of thirty-three specimens collected at Brownsville, Texas, by Prof. Herbert Osborn, in 1909, and now in his collection. These have been considered as variable specimens of *abbreviatus* until the present study has revealed them as a distinct species by means of the unique internal genitalia.

Latalus ocellaris var. **sobrinus** n. var.

Resembling *ocellaris* in form and appearance but more robust, broader and with different female segment. Length 3½–4 mm. Vertex about as long as width between eyes, bluntly angled. Elytra short and broad.

Color: Similar to *ocellaris* but more conspicuously marked. The pair of triangular spots near apex of vertex and the larger areas just back of these dark brown. Pronotum dark with five pale logitudinal lines. Elytra conspicuously mottled with brown and white. Commissural line bordered with white, clavus with cells heavily infuscated on inner margins. Base of wing, discal cell and apical and anteapical cells dark brown. Veins on central portion of wing broadly milk-white.

Genitalia: Female segment comparatively long, posterior margin gradually produced from lateral angles to form two short rounded teeth separated by a rounded or V-shaped notch. Posterior margin of segment black bordered. Male not known.

Described from six female specimens collected at Slave Lake, Alberta, Canada, August 14, 15 and 17, 1924, by O. Bryant, who forwarded these to the senior author. Other specimens have been examined from northern New York State.

Although *ocellaris* is reported for North America, all the specimens examined agree exactly with the above description and are different from European material at hand. European specimens of this species have a long produced tooth slightly bifurcate at the middle on the female segment. There are no intermediate forms and the North American type is described here and is in all probability a separate species.

Polyamius aestuarium n. sp.

In general appearance resembling *arundineus* and allied species but the coloration of wings and face gives it the appearance of a species of *Scaphoideus*. Length 4 mm.

Vertex slightly wider between eyes than length at middle, flat or slightly depressed on disc. Pronotum slightly longer than vertex, more than twice as wide as long. Elytra exceeding abdomen, central anteapical cell constricted and divided, the anterior cell twice as long as posterior.

Color: Pale yellow, a pair of oblique orange bands extending from the margin of the vertex to the central posterior portion of the disc. Pronotum with a large orange spot along anterior margin extending between the eyes, and a large round spot on central portion of pronotum behind either eye. Basal angles of scutellum orange. Elytra orange yellow, veins milk-white and heavily infuscated at certain places. A large spot on the costal margin at about its middle, discal, central anteapical and apical cells fuscous. Face black above, extending obliquely beneath the eyes. Clypeus and lorae yellow.

Genitalia: Female last ventral segment rather short on lateral margins, then produced to form a broad trilobate posterior margin, only a slight notch is found either side of central lobe but the coloration causes it to appear decidedly trilobate. Lateral portions of underlying segment produced beyond last ventral segment at either side.

Described from a single female specimen taken at Carolina Beach, Wilmington, N. C., June 24, 1928, by the senior author. This was collected from the tidal salt marsh area and is so named.

The question of placing this species is somewhat in doubt, but it is placed in *Polyamius* because it resembles so closely species of this group and because the female genital segment is almost exactly like the majority of the species of this genus.

Polyamius montanus, n. sp.

(Plates IV and IX).

Resembling *inimicus* in form and appearance but shorter with more bluntly angled head, slightly different coloration and genitalia distinct. Length 3½ mm.

Vertex about one-fourth wider between eyes than length at middle. Pronotum slightly longer than vertex. Elytra shorter and broader than *inimicus* with anteapical cell constricted and divided. Claval area with only a few cross veins.

Color: Vertex with a pair of small round black spots just above apex and a pair of large round ones about half way between these and either eye. A pair of small round black spots on anterior margin of pronotum. Black spots on basal angles of scutellum showing through

the pronotum. Veins of elytra slightly infuscated. Reflexed arcs of face not seen from above on vertex.

Genitalia: Female last ventral segment rather short, side margins very short then gradually produced and rounded to posterior margin which is slightly indented either side of a central broad slightly produced tooth. Underlying membranes conspicuous beyond short lateral margins. Male valve broad and only slightly produced. Plates as broad as valve at base, gradually, concavely tapered to acutely pointed tips.

Described from a series of two female and ten male specimens collected July 12, 1927, by Dr. Walter Carter at Bozeman, Montana. Two males, one of which is designated as the type, are in the collection of the senior author. The others which have been examined in the National Museum collection are designated as paratypes. A series of specimens collected by Dr. Martha Shackleford, at Friday Harbor, Washington, during the summer of 1928, are undoubtedly the same species.

Laevicephalus cicatrix, n. sp.

(Plates V and VIII).

Resembling *striatus* in form and appearance but with head slightly more angled and genitalia distinct. Length 3½–4 mm.

Vertex bluntly angled, a little wider between eyes than length at middle. Pronotum shorter than vertex, very short behind the eyes. Elytra slightly longer than abdomen, outer anteapical cell very short.

Color: In coloration resembling a well marked specimen of *striatus*. Face with nine pairs of brownish arcs, the ventral pairs paler. Vertex with a pair of converging curved lines extending from ocelli to either side of apex, and a median line extending two thirds of the way from base to apex, brown. Veins of elytra heavily infuscated. Ovipositor black or dark brown.

Genitalia: Female last ventral segment rather long, roundingly produced from either side to central third which is rather abruptly roundingly emarginate either side of a slightly produced central lobe which is slightly notched at center. Base of emargination either side, with a black spot. Male valve more than twice as broad as long, bluntly rounded. Plates about twice longer than valve, convexly rounded to rather broadly rounded apices. Male internal genitalia distinct as indicated.

Described from a series of eight female and seven male specimens collected at Slave Lake, Alberta, Canada, August 14 to 17, 1924, by Mr. O. Bryant and forwarded to the senior author for identification.

Laevicephalus orbiculus, n. sp.

(Plates V and VIII).

Size and coloration of *debilis* and resembling it very much. Head more bluntly angled and genitalia distinct. Length 3½ mm.

Vertex very bluntly angled, slightly wider between eyes than length at middle. Pronotum shorter than vertex and more than twice as wide as long, lateral margins very short. Elytra short and broad, flaring.

Color: Vertex, pronotum and scutellum straw yellow, slightly tinted with green, elytra dark green, veins yellowish. Ocelli black. Dorsal portion of abdomen mostly black.

Genitalia: Female last ventral segment rather long, lateral angles produced and prominent, between which the posterior margin is concavely rounded about one-third the distance to the base at the center of which a slight notch forms a pair of slightly produced rounded black teeth. Male valve rather broadly rounded. Male plates broad, gradually tapering to blunt rounded tips, a black spot about the middle of each plate. Pygofers scarcely longer than plates. Male internal genitalia distinct.

Described from thirteen female and eight male specimens collected at Mammoth Hot Springs, Wyoming, July 9, 1909, by Professor Herbert Osborn and now in his collection.

This species can best be separated from *debilis* by the male and female genital characters. The male of *debilis* has plates which are more convexly rounded and greatly exceeded by long pygofers. The female segment of that species does not have prominent angles on the last ventral segment.

Laevicephalus subrutilus, n. sp.

(Plates V and VIII).

Resembling *auratus* in form and coloration, but more yellowish with vertex more produced and angled. Male plates more narrowed and produced, internal genitalia greatly different. Length 3 to 3½ mm.

Vertex bluntly angled, as wide between eyes as length at middle and one-fourth longer than pronotum. Pronotum broad and very short at lateral margins. Elytra when of the brachypterous type exposing the last two dorsal segments. Usually this type of wing is present in the female specimens.

Color: A rather uniform orange yellow without definite markings. The toothed portion of the female segment is black margined. As contrasted with *auratus* it shows more yellow and less of the bright, distinct orange color.

Genitalia: Female last ventral segment rather long, lateral angles produced and broadly sloping to central excavated portion, at the

base of which is found a rather broad, produced tooth which is black margined and appears slightly incised at middle. Male valve bluntly angled, male plates rather long, gradually tapering to rounded apices. In *auratus*, with which this species has been confused, the plates are much broader and shorter.

Described from a series of six female and two male specimens all collected at Dickinson, N. D., by Prof. Herbert Osborn. Type in Osborn collection. This species has been confused for many years with *auratus*, which it resembles very much superficially. The shorter, blunt head character, the more orange coloration, the external and internal genital characters as described and figured will easily separate these two species.

Deltocephalus comesus, n. sp.

(Plates VII and VIII).

Resembling *balli* in size and coloration, slightly more robust and with distinct male genitalia. Length 3–3½ mm.

Vertex broadly bluntly angled, almost rounded, slightly more than half as long on middle as width between the eyes. Pronotum longer than vertex and more than twice as broad as long. Elytra with middle anteapical cell constricted and divided.

Color varying from yellow to light brown with definite markings more or less distinct. Vertex with four black spots varying in size just above margin and a transverse dash either side behind the ocellus extending from eye almost to outer spot. Vertex pronotum and basal angles of scutellum more or less mottled with orange.

Genitalia: Female last ventral segment with prominent lateral angles, broadly angularly excavated halfway to base. Central third heavily embrowned. Male valve broadly convexly rounded, plates short, exceeding valve by about its length, gradually tapering to blunt broadly rounded apices. Male internal genital structures distinct as illustrated.

Described from five female and three male specimens from Brownsville, Texas, June 23, 1908, and one female specimen from Arizona. Type in collection of senior author.

EXPLANATION OF PLATES.

PLATE I.

Ventral and lateral view of internal genitalia in situ.
Genus *Flexamius*.

PLATE II.

Ventral and lateral view of internal genitalia in situ.
Genus *Alapus*, Genus *Latalus* and Subgenus *Secopennis*.

PLATE III.

Comparative view of styles (top) and oedagi from ventral and lateral views of species of genera in Plates I and II.

PLATE IV.

Ventral and lateral view of internal genitalia in situ.
Genus *Palus* and *Polyamius*.

PLATE V.

Ventral and lateral view of internal genitalia in situ.
Genus *Laevicephalus*.

PLATE VI.

Ventral and lateral view of internal genitalia in situ.
Genus *Laevicephalus* and *Hebecephalus* (lower right).

PLATE VII.

Ventral and lateral view of internal genitalia in situ.
Genus *Amplicephalus* (top) and *Deltocephalus*.

PLATE VIII.

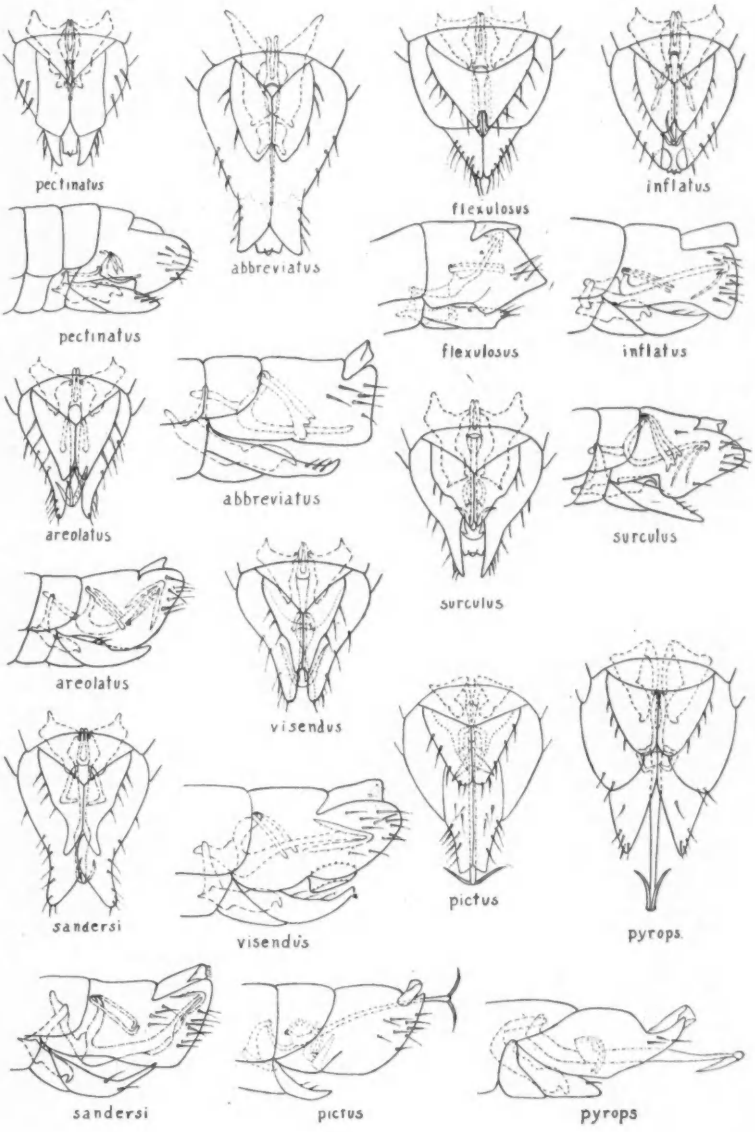
Comparative view of oedagi, ventral aspect (top) and lateral (lower) of Genera *Laevicephalus*, *Hebecephalus*, *Amplicephalus* and *Deltocephalus*.

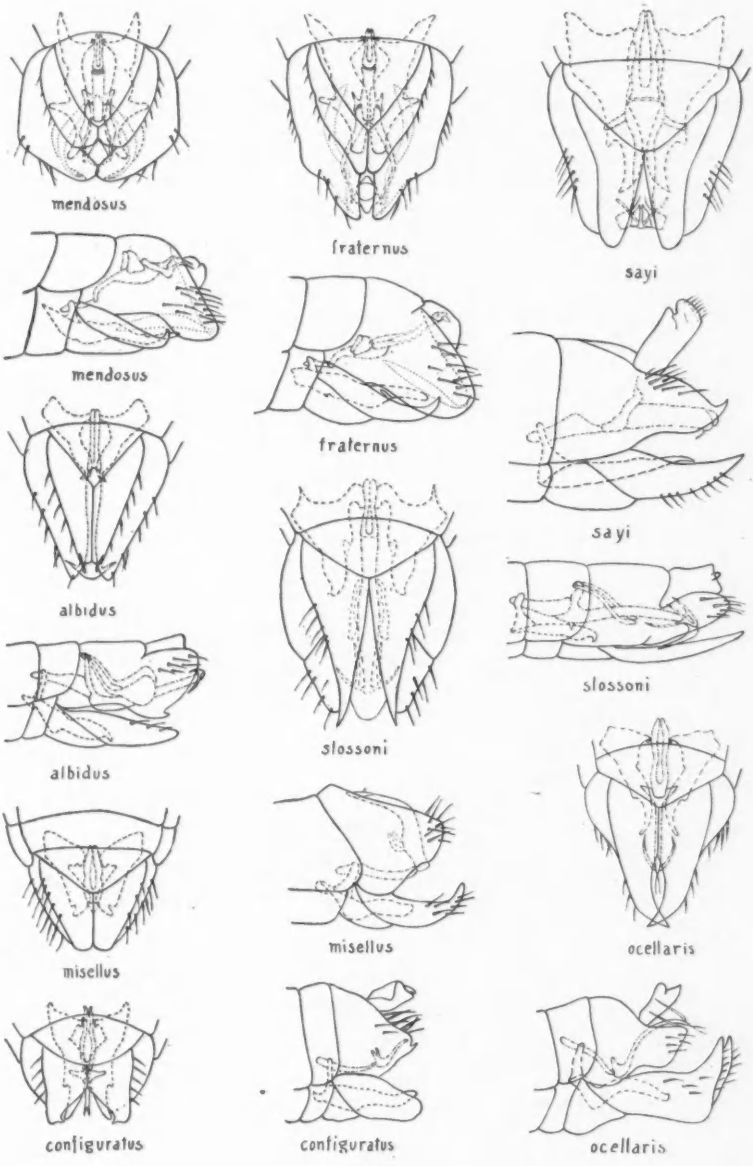
PLATE IX.

Comparative view of oedagi ventral and lateral aspects (top) and styles (middle) of Genera *Palus* and *Polyamius*. Ventral view of styles (lower) of Genera *Laevicephalus*, *Hebecephalus*, *Amplicephalus* and *Deltocephalus*.

Genera of Deltocephalus
Delong and Sleesman

PLATE I

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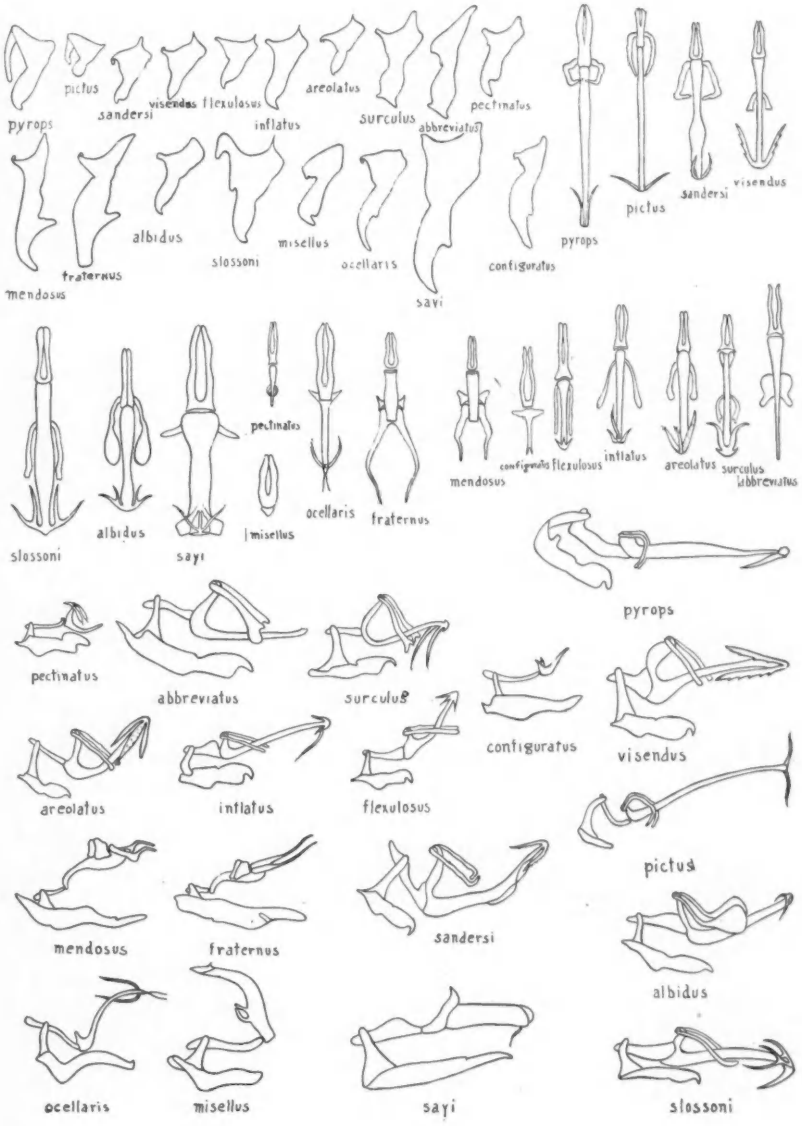
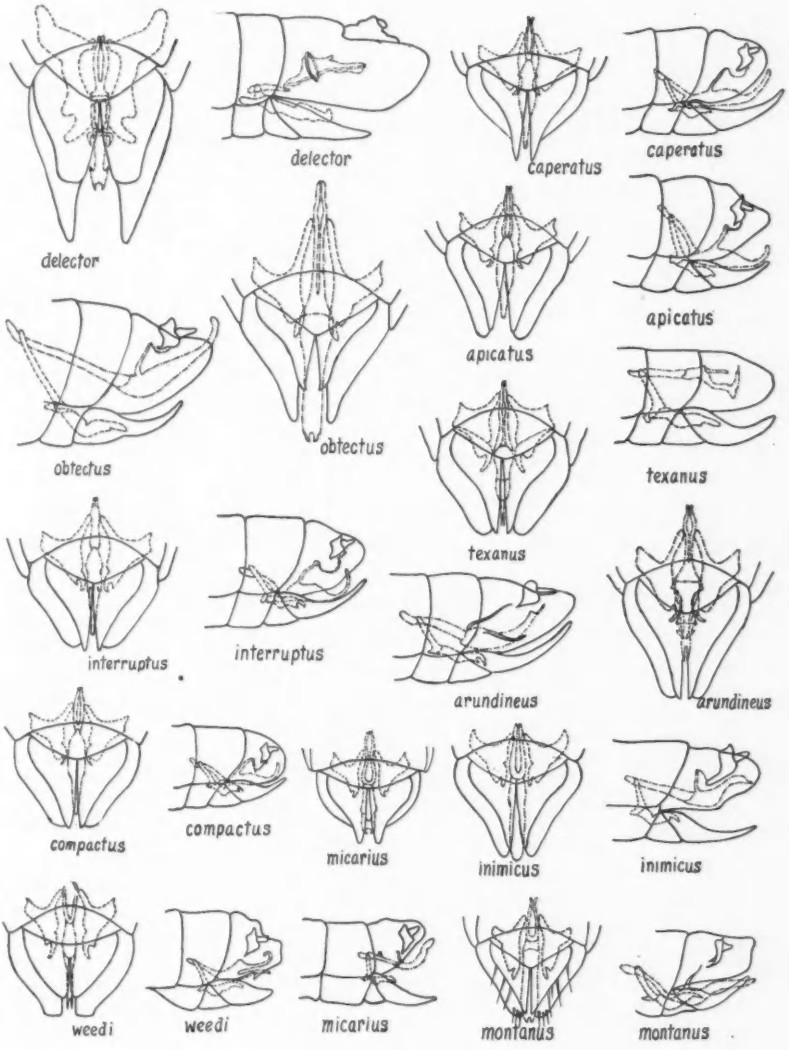
Genera of Deltocephalus
Delong and Sleesman

PLATE III

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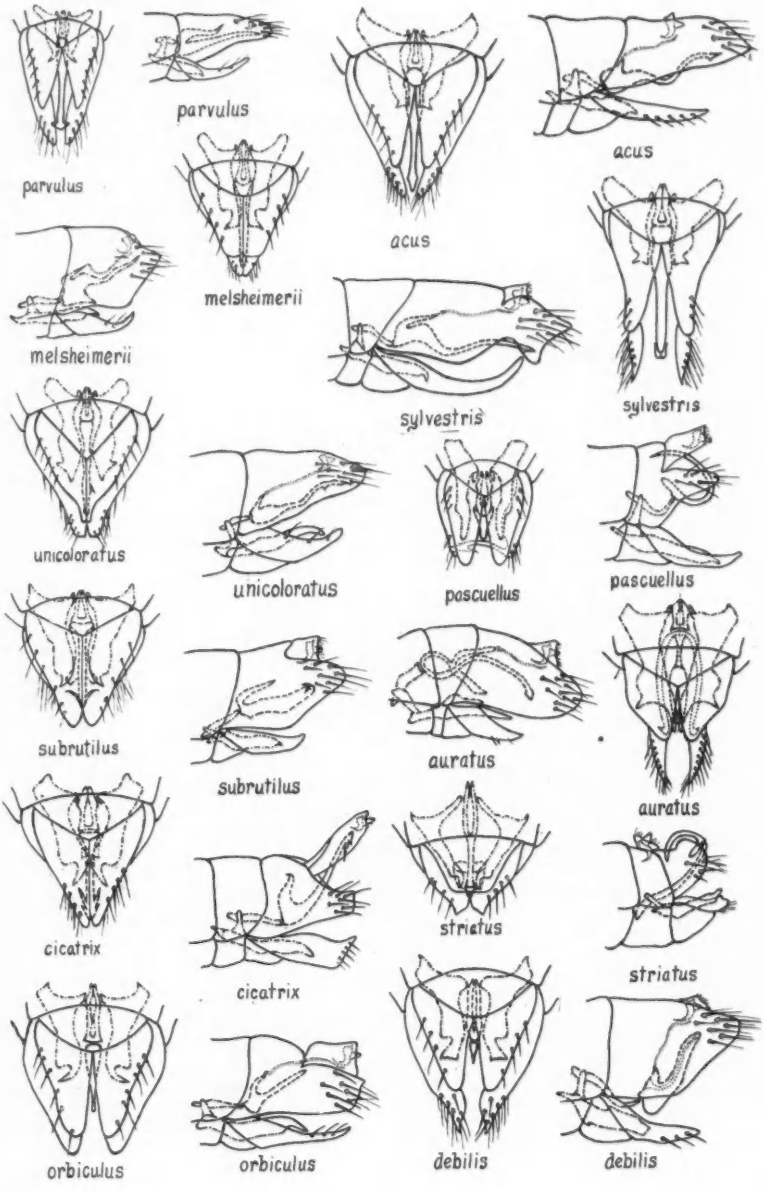
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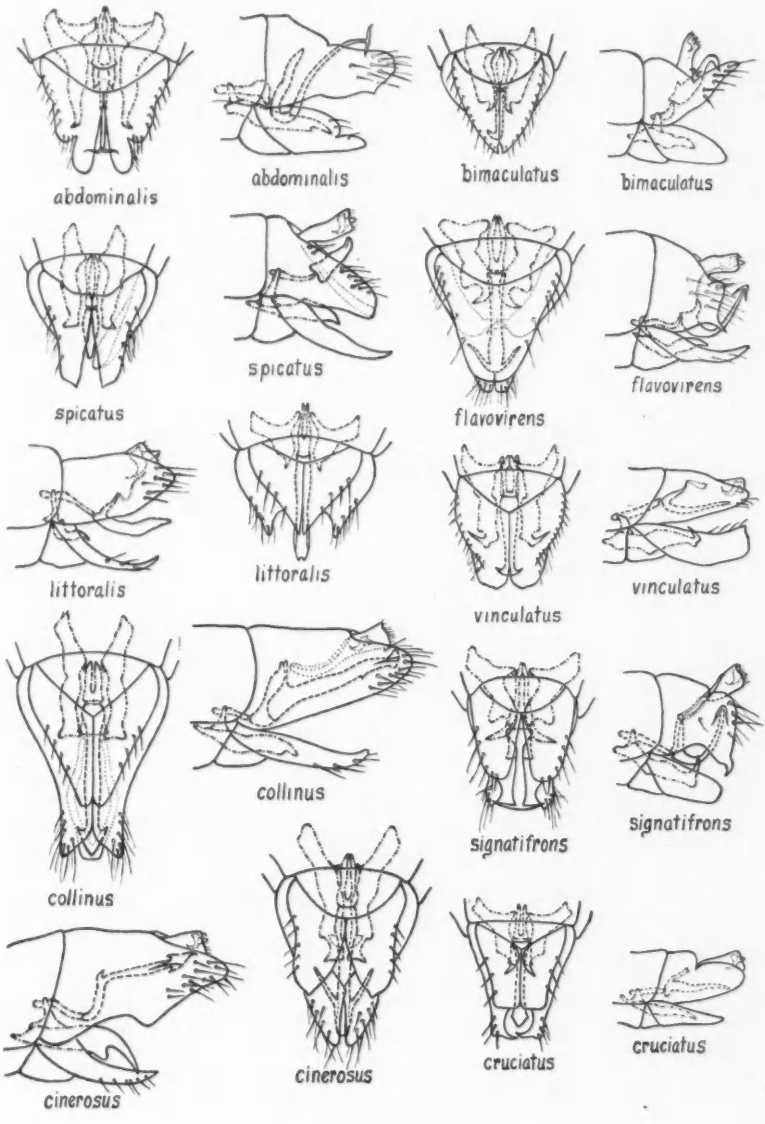
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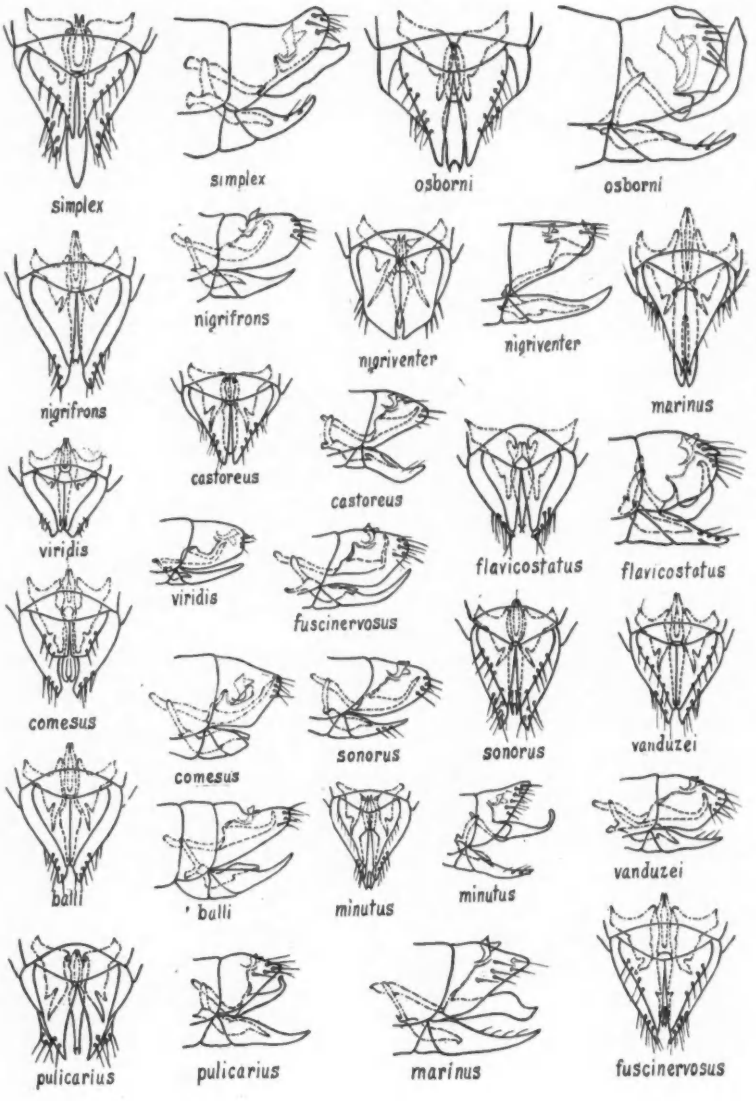
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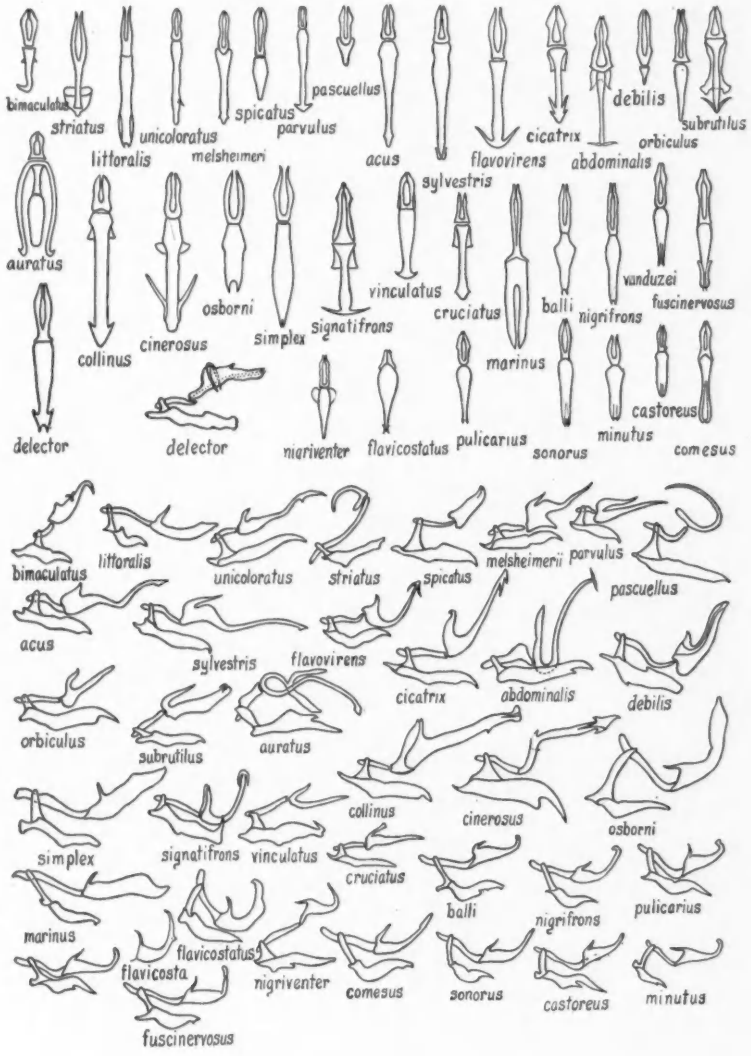
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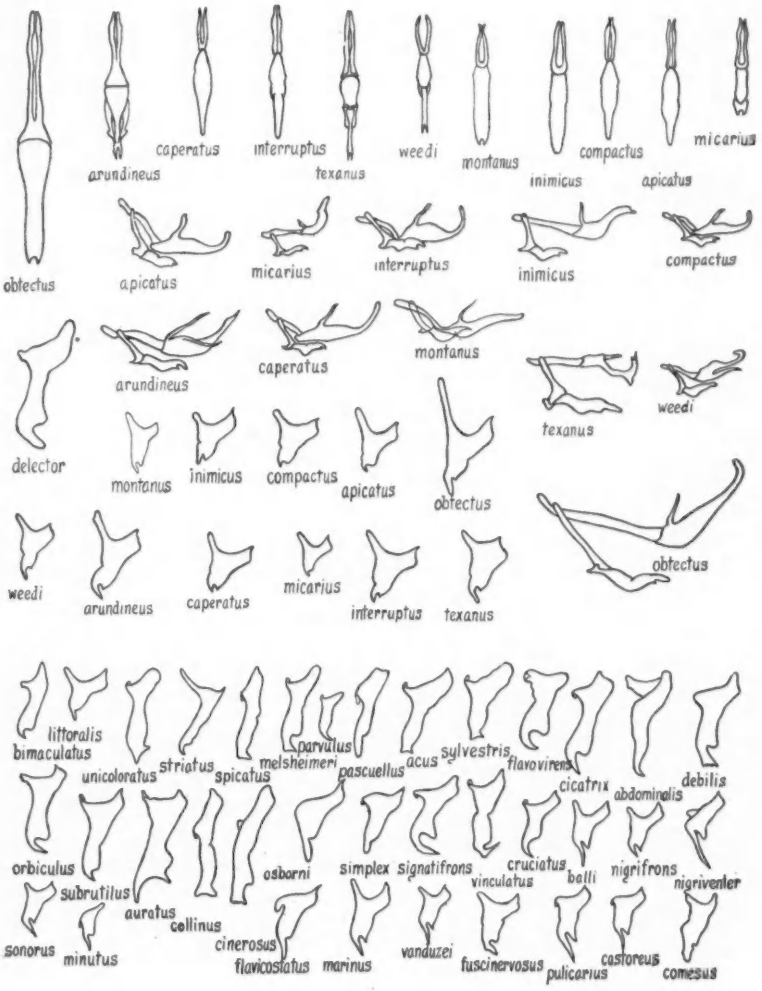
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vanduzei
fuscinervosus
pulicarius
castoreus
comesus

ERYTHRONEURA (HOMOPTERA, CICADELLIDÆ) FROM THE SOUTHWEST.*

R. H. BEAMER,
University of Kansas.

The Biological Survey Party from the Department of Entomology of the University of Kansas spent the summer of 1927 collecting in the southwest part of the United States. (Arizona, New Mexico and southwestern Texas). The objectives of the party were two fold: first, to make an intensive survey of the aquatic Hemiptera of this region; and second, to visit, as far as time would permit, the localities where Professor F. H. Snow had collected in former years. The trip was a very profitable one, yielding about 25,000 specimens, a number of which are new. The present paper deals with the species of Erythroneura collected in that region.

To a native of Kansas, accustomed to collecting Erythroneura by the thousands, their scarcity in this western region was disappointing. Wild grape vines and scrub oak in one or two localities produced specimens in numbers, but these were represented by a very few kinds. Most of the specimens were taken, a few here and a few there, by arduous work with the sweep net. The fact that twenty-three of the twenty-one species taken were new to science compensates somewhat for their lack in numbers.

Following the example of previous writers in this group the male genitalia were dissected and studied. Unlike them, however, they were mounted on slides and photographed rather than drawn, care being taken to get the various specimens in the same relative position.

Species were found which belonged to the various groups as established by W. L. McAtee and Wm. Robinson, as well as a number of species with two types of genitalia not hitherto mentioned. One of these is represented by one species which externally has characters between Hymetta and Erythroneura, although more like the latter. The male genitalia, (Plate II,

*Contribution from the Department of Entomology, University of Kansas, Lawrence, Kansas.

Fig. 19), could belong to the Scutelleris group of Erythroneura although they are totally unlike any known species. The other type of genitalia represented by eleven species, is characterized by the pygofer having two hooks or processes which come from different portions of the pygofer and project more or less toward each other, and by a sameness in the shape of the claspers. It could be argued that these two types of genitalia should be set off as generically distinct. The specimens of both groups, however, fall easily into the genus Erythroneura on external characters, so no need is seen for additional names.

The twenty-six species known to occur in this region, have been included in the key. Twenty-three of them were collected on this trip. Twenty-one of them are new to science. All types are deposited in the Snow Entomological Collection.

KEY TO THE SPECIES.

A. With longitudinal oblique stripes on dorsum.
  B. Vertex, pronotum and scutellum without definite markings.
    C. Body light colored ..... *pallenta*
  CC. Body dark.
    D. Large species, oblique markings, very light ..... *obscura*
    DD. Smaller species, oblique markings distinct ..... *triceroprocta*
BB. Vertex, pronotum and scutellum with markings.
  C. Vertex with dark markings.
    D. Vertex with one dark spot ..... *casta*
    DD. Vertex with three or four dark spots ..... *tripunctata*
  CC. Vertex with faint oblique stripes, no dark spots.
    D. Costal margin of tegmen without vitta ..... *cimarroni*
    DD. Costal margin with lemon-yellow vitta ..... *pinalensis*
AA. With markings otherwise.
  B. Without markings ..... *unicolor*
BB. With markings.
  C. Markings in the form of cross-bands.
    D. With five cross-bands ..... *canyonensis*
    DD. With seven cross-bands ..... *nicholi*
  CC. Markings otherwise.
    D. M-Cu cross-vein absent, M_{3+4} and Cu forming a more or less continuous line.
      E. Base of cell M_4 oblique, apex of cell R_3 without a black cloud or spot.
        F. Both vertex and scutellum with two black dots ..... *bipunctata*
        FF. At least scutellum without black dots.
          G. Markings usually red ..... *carmini*
          GG. Markings orange ..... *texana*
      EE. Base of cell M_4 square, apex of cell R_3 with a black spot or cloud.
        F. Base of scutellum with two black spots ..... *coloradensis*
        FF. Base of scutellum without two black spots.
          G. Apex of vertex with a black dot ..... *aprica*
          GG. Apex of vertex without a black dot.
            H. Markings of pronotum usually U-shaped ..... *ancora*
            HH. Markings of pronotum usually Y-shaped.
              I. Tegminal vittæ broad, fusco-rufous ..... *anfracta*
              II. Tegminal vittæ orange ..... *gilensis*

DD. M-Cu cross-vein present.
E. Base of cell M_4 oblique, almost a straight line.
F. Tip of scutellum black.....*kiperi*
FF. Tip of scutellum light.
G. Distinctly three-colored, face with a black band crossing it.....*tricolor*
GG. Markings orange, no band on face.....*milleri*
EE. Base of cell M_4 distinctly angled, not a straight oblique line.
F. Color markings consisting of scattered spots.
G. Black spots of tegmina almost circular.....*illinoiensis*
GG. At least one black spot on tegmina much elongated, *illinoiensis* var. *regalis*
FF. Color markings almost solid.
G. Costal plaque with a red blotch.
H. Large, female 3.7 mm.....*grandis*
HH. Smaller, female 2.7 mm.....*rubicunda*
GG. Costal plaque without red blotch.....*variabilis*

Erythroneura pallenta n. sp.

General ground color yellowish white. Vertex, pronotum and scutellum without markings. Tegmina with faint, yellow, parallel, oblique stripes, one near middle of clavus, another following cubitus and a third on costal margin from humeral angle to cross-veins, the latter about as wide as the costal plaque. Cubital vittæ decidedly narrower than the others. Tegmina, from cross-veins to apex, slightly fumose. Abdomen straw colored throughout.

Genitalia.—Pygofer with two large hooks. Oedagus quite long, ending in a triangle, without other processes. In this it differs from *cimarroni* n. sp. to which it seems to be related. (Pl. I, Fig. 6 and 6a).

Holotype, male; Oak Creek Canyon, Arizona, August 14, 1927; R. H. Beamer.

Erythroneura obscura n. sp.

General ground color yellowish white. Vertex, pronotum and scutellum without markings. Tegmina with very faint yellow lines through middle of clavi and along cubitus. Slightly smoky beyond cross-veins. Abdomen more or less darkened throughout.

Genitalia.—A heavy oedagus characterizes the genitalia. It ends in a triangular-shaped head. The tip curves up in lateral view, as do the two posterior angles. The pygofer has two hooks or spines, both of them pointing posteriorly. (Pl. I, Fig. 1 and 1a). This character would seem to relate this species more closely to *triceroprocta* n. sp. (Pl. I, Fig. 10 and 10a). than to the others with double pygofer hooks.

This species externally closely resembles *pallenta* n. sp. but may be distinguished from it by the dark abdomen, the much fainter lines on tegmina and by the male genitalia.

Holotype, male; Huachuca Mts. Ariz. August 1, 1927; R H. Beamer.

Erythroneura triceroprocta n. sp.

General ground color semi-hyaline to whitish. Vertex, pronotum and scutellum tinged with yellow, no definite markings. Tegmina with two narrow, oblique, parallel stripes. The first runs through middle of clavus and the second follows cubitus. In some specimens media and radius are tinged with yellow for a short distance before the cross-veins.

Genitalia.—Pygofer hooks, two, posterior one small and projecting posteriorly. Oedagus extremely large and heavy, flattened laterally and divided into three main divisions, the median one of which again divides into two processes which bend out near their middle at right angles, making a laterally-flattened, four-pronged, dorsally-curving, organ. (Pl. I, Fig. 10 and 10a).

This species externally looks much like *obscura* n. sp., but is smaller and the oblique markings are more distinct, while the male genitalia are nothing like any other named species.

Holotype, male; Culberson Co., Texas; July 7, 1927; R. H. Beamer. *Allotype*, female; eight female and four male paratypes, same data.

Erythroneura casta n. sp.

General ground color yellowish white to hyaline. Apex of vertex with small circular black spot, from which in some specimens a dark narrow line extends to pronotum. A more nearly lemon yellow spot at base; two triangular orange spots near base of pronotum, separated by a rather broad whitish stripe. Middle two-thirds of clavi from base of tegmen to slightly beyond anterior end of costal plaque, orange. This continues to tip of clavi as lemon-yellow stripe. Corium marked with two lemon-yellow stripes, the outer as wide as costal plaque, extending from base of tegmen to the region of cross-veins; the inner of about same width as outer and beginning even with the anterior end of costal plaque, ending at the cross-veins. Tegmina from cross-veins to apex smoky.

Genitalia.—Pygofer hooks two in number. Oedagus, viewed dorsally, has two pairs of processes, one from base and one from apex, the ends of which diverge somewhat as they approach each other. (Pl. I, Figs. 8 and 8a).

Holotype, male; Huachuca Mts., Arizona, August 1, 1927; R. H. Beamer. *Allotype*, female; 38 female and 127 male paratypes, same data.

All specimens were swept from very short, scrubby oaks growing on the east side of Car Peak a short distance from the top.

Erythroneura tripunctata n. sp.

General ground color semi-hyaline except vertex, pronotum and scutellum, which are yellowish white. Vertex with three fuscous spots at apex, an indication of a median fuscous line at base. Pronotum with two indefinite yellow vittæ slightly diverging anteriorly and a smoky circular spot on each lateral margin. Some specimens have other smoky blotches. Scutellum with basal angles and extreme tip smoky. Tegmina hyaline except two faint, parallel, lemon-yellow vittæ, one near middle of clavi, the other near cubitus, and with slight fumosity from cross-veins to tip.

Genitalia.—Pygofer hooks double. Oedagus broad and heavy in lateral view, with a pair of heavy ventral processes. (Pl. I, Figs. 5 and 5a).

Holotype, male; Oak Creek Canyon, Arizona, August 14, 1927; R. H. Beamer. *Allotype*, female; three female and one male paratypes, same data. Five female and one male paratypes, Culberson Co., Texas, July 10, 1927; R. H. Beamer.

Erythroneura cimarroni n. sp.

General ground color pale yellowish white on vertex and pronotum; tegmina light, almost hyaline with oblique, parallel, lemon-yellow stripes. Vertex and pronotum in some specimens slightly tinged with oblique stripes; claval stripe narrow, in middle of clavus, parallel with claval suture. Corial stripe follows cubitus to cross veins. Media and radius often slightly yellowed.

Genitalia.—Pygofer hook double. Oedagus long, ending in triangular head with two backward projecting processes. (Pl. I, Figs. 7 and 7a).

Holotype, male; Colfax Co., New Mexico, August 21, 1927; R. H. Beamer. *Allotype*, female; two male and seven female paratypes, same data.

This species is apparently related to *pallenta* n. sp., according to the male genitalia. It differs from that species principally in the processes of the oedagus.

Erythroneura pinalensis n. sp.

General ground color semi-hyaline, except pronotum and vertex, which are pearly white. Vertex with median light stripe bordered by two curved, yellowish vittæ, which curve sharply outward anteriorly, ending in darkened area in one specimen, and which expand rapidly posteriorly. The same condition exists on pronotum, except that the yellow vittæ curve out posteriorly instead of expanding. Scutellum with basal triangles yellow and extreme tip fuscous. Tegmina hyaline, with three longitudinal lemon-yellow vittæ; first in center of clavi; second on cubitus; and third on costal margin including costal plaques.

Tip of clavi and tegmina, from slightly anterior to cross-veins, lightly fumose in some specimens.

Genitalia.—This species has the double pygofer hooks and a very peculiar œdagus with its seven upward projecting hooks. It does not resemble the œdagus of any of the other species. (Pl. I, Figs. 4 and 4a).

Holotype, male; Pinal Co., Arizona; August 6, 1927; R. H. Beamer. *Allotype*, female; one male paratype same data.

Erythroneura unicolor n. sp.

General ground color white, slightly tinged with yellow. Practically no other markings. On the holotype there is a slight orange tinge for a short distance on the mesal margin of the clavi almost to the tip. The vertex, eyes and basal angles of scutellum tend to have a purplish cast. This species is practically concolorous.

Genitalia.—Genitalia very characteristic, with pygofer hooks double, the anterior one composed of two hooks, and the long heavy œdagus with its pair of anteriorly projecting processes coming out near its apex. (Pl. I, Fig. 9 and 9a).

Holotype, male; Culberson Co., Texas; July 10, 1927; R. H. Beamer. *Allotype*, female and three paratype females, same data.

Erythroneura canyonensis n. sp.

Close to *nicholi* Beamer, although it has but five cross-bands while *nicholi* has seven.

General gound color pearly white, with cross-bands of darker color. Vertex yellowish white, fumose mesally. Pronotum fuscescent, a small portion of anterior margin of same color as vertex. First cross-band, including most of pronotum, scutellum and bases of tegmina, reddish brown on tegmina and scutellum. Second band white, extending to middle of clavus. Third band ferrugineous, extending about to posterior edge of costal plaque. Fourth band white, extending almost to cross-veins, with a tendency to a broken ferrugineous line near its middle. Fifth band fuscous, occupying remainder of tegmina. Cross-veins whitish. Venter dark.

Genitalia.—Genitalia characterized by broad œdagus, from lateral view, tapering into a long slender tip. Basally a pair of rather heavy processes project parallel with the œdagus about one-third its length. These are much larger in this species than in *nicholi* Beamer. Pygofer has two hooks. (Pl. I, Figs. 2 and 2a).

Holotype, male; Grand Canyon, Arizona; August 11, 1927; R. H. Beamer. *Allotype*, female, and 27 male and 6 female paratypes, same data.

All the specimens were collected about 900 feet down from the rim of the Grand Canyon on Bright Angel trail.

Erythroneura nicholi Beamer.

A photograph of the male genitalia is included to help separate it from *canyonensis* n. sp. No specimens of this species were taken. (Pl. I, Figs. 3 and 3a).

Erythroneura bipunctata (Gill.).

This species was not collected, but is included because it was described from this region.

Erythroneura carmini n. sp.

General ground color milky white. Vertex usually with three dark red spots. Pronotum with a dark red spot in each anterior angle and a larger median one of varying size and shape, often a short heavy V. Scutellum with lateral angles usually margined with dark red and a large spot on tip of same color. Tegmina with the following bright red markings: clavus with anchor-shaped mark on anterior two-thirds, which usually does not touch the claval suture, the base of clavus nor the inner margin and a much smaller spot bordering the inner margin and near the tip; corium with oblique vitta beginning on costal margin near humeral angle and ending on claval suture, a zigzag vitta beginning in costal margin at anterior end of costal plaque touches the claval suture in two places ending on M_2 just short of the cross-veins. A black spot in posterior end of costal plaque and a larger one in base of cell M_4. Apex of tegmen dusky. A bright red spot on mesosternum beneath base of wings.

Genitalia.—Pygofer hook composed of two almost equal processes, the inner heavier and slightly shorter. Oedagus moderately short and slightly bulbous. (Pl. II, Figs. 13 and 13a).

Holotype, male; Anderson Co., Kansas; September 9, 1927; R. H. Beamer. *Allotype*, female; Gila Co., Arizona; August 5, 1927; R. H. Beamer. *Paratypes*, 4 females and 4 males, Gila Co., Arizona; August 5, 1927; 1 female and 1 male, Oak Creek Canyon, Arizona, August 14, 1927; 7 males, Douglas Co., Kansas, 1926; 1 male, Cloud Co., Kansas, 1927; 7 males, Cherokee Co., Kansas; 2 males, Anderson Co., Kansas; 1 male, Colfax Co., New Mexico, August 21, 1927; R. H. Beamer.

Erythroneura texana n. sp.

General ground color creamy white. Vertex with a median orange circle enclosing a white dot. Pronotum with a median U-shaped orange mark broadest near middle, not extending to either margin, and an orange spot in each anterior angle. Scutellum with an outline of a triangle in basal angle and tip orange. Tegmina with following orange markings: an oblique vitta enlarged caudally to face the tegminal

suture in basal half of clavus; spot near tip of clavus; an oblique vitta on corium near humeral angle; a continuous more or less irregular vitta bordering the inner margins of the costal plaque, enlarged to meet the one on the clavus at claval suture and extending to cross-veins. A small black spot in apex of costal plaque and a much larger one in base of cell M_4. Tegmina apically dusky.

Genitalia.—Pygofer hook single, sword-shaped, bent ventrally near its middle to about a 120 degree angle. Oedagus short and straight, with sharp heavy spine slightly anterior to the base of the shaft. (Pl. II, Figs. 15 and 15a).

Holotype, male; Culberson Co., Texas, July 10, 1927; R. H. Beamer. *Allotype*, female and 4 female paratypes, same data.

Erythroneura coloradensis (Gill.).

This species was taken in numerous localities on wild grape.

Erythroneura aprica McAtee.

This species was not taken but is included because it was named from the Santa Rita Mts., Arizona.

Erythroneura ancora n. sp.

General ground color on vertex, pronotum and scutellum yellowish white, on tegmina whitish hyaline. Vertex marked with an inverted yellow V which continues on pronotum as a U. This U is as wide or wider than long. Sides of pronotum with an orange vitta almost its entire width. Lateral angles of scutellum yellow. Tegmina with the following orange markings: on clavus a vitta in touch with basal half of claval suture with a caudal projection which meets the tegminal suture and a spot almost to tip; on corium an oblique line arising near the humeral angle and meeting the middle of the claval vitta, another which borders the front and inner margins of the costal plaque uniting in a broad stripe with the claval vitta and near posterior end of costal plaque extending in an oblique line to unite with the base of cell M_4 in a narrowed vitta. Cross-veins red. Diagonal vitta along posterior end of costal plaque, spots in base of cell M_4, and in apex of cell R_3 fuscous. Cells R_3, M_2, and M_4 slightly fumose.

Genitalia.—Pygofer hook U-shaped, typical of the *comes* group. Oedagus, viewed laterally, is long, curved almost into a circle and tapers rapidly from the base outward. (Pl. II, Figs. 11 and 11a).

This species resembles *gilensis* n. sp. externally, from which it may be separated by the U on pronotum instead of a Y, by the orange vitta of corium reaching the cross-veins and by the male genitalia.

Holotype, male; Culberson Co., Texas, July 10, 1927; R. H. Beamer. *Allotype*, female and one male paratype, same data.

Erythroneura anfracta n. sp.

General ground color pearly white tinged with yellow on vertex and pronotum. Vertex marked with a yellowish-orange inverted V which is continued on the pronotum in a Y. Lateral margins of pronotum with an orange bar extending almost to posterior margin. Tip of scutellum yellow, basal angles dusky yellow. Tegmina reddish orange, fumose in some places (basal two-thirds of clavus and just above the costal plaque), to the cross-veins with the following light areas: an oval spot at tip of scutellum, a diamond shaped area extending from middle of clavus to cross-veins and surrounding an orange spot at tip of clavus, a diagonal bar arising on costa between costal plaque and humeral angle and extending to claval suture, the costal plaque and a triangular area occupying space posterior to black bar at posterior end of costal plaque to cross-veins. Cross-veins red. An indefinite margined black bar arising near base of cell M_4 in a darker spot, extends diagonally to tip of cell R_3 ending likewise in a darker spot. Mesosternum more or less darkened.

Genitalia.—Pygofer hooks U-shaped, typical of the *comes* group. Oedagus heavy, ending in a triangular form with tube projecting. Two ventral processes arise near its base, curve up and out with a twist or turn near their base. This turn is more exaggerated in some specimens than in others. (Pl. II, Figs. 12 and 12a).

Holotype, male; Pinal Co., Arizona, August 6, 1927; R. H. Beamer. *Allotype*, female; same data. *Paratypes*, 44 males and 37 females, same data.

Erythroneura gilensis n. sp.

General ground color creamy white with the following orange markings: vertex, two posteriorly diverging vittae making an inverted V-shaped mark; pronotum, a broad Y-shaped vitta with arms and base of about equal width and length, a vitta on each lateral margin; scutellum, a solid spot or outline of one in each basal angle and a spot at the tip; tegmina, on clavus a vitta in touch with basal half of claval suture with a caudal barb which meets the tegminal suture and spot near tip of clavus; on corium an oblique line arising near the humeral angle and meeting the middle of the claval vitta, another which borders front and inner margins of costal plaque and then proceeds to the base of cell M_4. An oblique dark mark in the apex of costal plaque; a black dot in the apex of cell R_3 and base of cell M_4.

Genitalia.—Pygofer U-shaped. Oedagus heavy, with lateral wings near apex. A pair of processes arise ventrally near the base and, bending out near their middle, extend beyond the œdagus. (Pl. II, Figs. 14 and 14a).

This species belongs to the *comes* group of Robinson and is quite close to *E. beameri* Rob. It differs from that species in that the color markings are narrower throughout and in the characters presented by the male genitalia.

Holotype, male; Gila Co., Arizona, August 5, 1927; R. H. Beamer. *Allotype*, female, same data. *Paratypes*, 16 male and 7 females, same data; 2 males and 1 female, Tucson, Arizona, June 7, 1926, A. A. Nichol; 8 females and 9 males, Pinal Co., Arizona, 1927, R. H. Beamer.

Erythroneura kiperi n. sp.

General ground color yellowish hyaline, slightly darker anteriorly, uniformly colored with the following exceptions: two small spots at base of scutellum brownish, tip of scutellum fuscous, small spot near center of clavi and faintly smoky area in region of cross-veins.

Genitalia.—Pygofer has large flat rectangular hook whose posterior corners project into two short diverging processes. Oedagus a straight heavy shaft ending in three small hooks. (Pl. II, Figs. 19 and 19a).

The tip of the scutellum turns up somewhat as in Hymetta, but it has no other resemblance to that genus.

Holotype, male; Mescal, Arizona, July 28, 1927; R. H. Beamer. *Allotype*, female, same data. *Paratypes*, 3 females and 9 males, same data; 1 female, Colfax Co., New Mexico, August 21, 1927; 21 females and 15 males, Cochise Co., Arizona, July 29, 1927; 1 male, Pinal Co., Arizona, July 27, 1927; R. H. Beamer.

Erythroneura tricolor n. sp.

Ground color yellowish white. Vertex more nearly yellow in a large circular spot near middle. Pronotum with large rectangular area on center of disc with comma-shaped spot at each anterior corner of same color. Scutellum with a rectangular golden-yellow area at basal angles, median portion white tinged with yellow, tip more strongly colored. Tegmina covered from base to slightly beyond the costal plaques, except yellowish white rectangular areas near center of clavi, by a large blotch of red shading to fuscous on outer margin, this fuscous margin extending posteriorly to apex of tegmina; hyaline areas covering base of cell R, apex of cell R and M_2. M_1 somewhat cloudy. Apex of clavi, first and second sectors and base of cell M_4 yellowish white.

Venter stramineous except a fuscous stripe beginning at posterior edge of thorax, extending anteriorly beneath base of wings, coloring ventral half of eyes and crossing the face in a strikingly distinct band.

Genitalia.—Pygofer with two hooks, the posterior one much longer than the other. Oedagus, viewed laterally, resembles an S ending in a knob with a backward projecting process. (Pl. II, Figs. 18 and 18a).

Holotype, male; Huachuca Mts., Arizona, August 1, 1927; R. H. Beamer. *Allotype*, female; and *Paratypes*, 7 females and 5 males, same data.

All specimens were swept from oak on the east side of Car Peak, Huachuca Mts., Arizona.

Erythroneura milleri n. sp.

General ground color semi-hyaline to yellowish white. Apex of vertex without black spots in most specimens; those from Arizona with black spots. Vertex pronotum and scutellum each with a pair of orange spots which form two parallel longitudinal rows. Extreme apex of scutellum also orange. Clavi with an indefinite orange anchor-shaped spot occupying most of basal two-thirds. Cell Cu beginning at posterior end of this anchor mark in clavus more or less orange almost to cross-veins. Slightly smoky in region of cross-veins. Some specimens more or less orange blotched about costal plaque.

Genitalia.—Pygofer hook a short heavy spine-like process. Oedagus viewed laterally, characterized by a very heavy base and a long curving shaft which in contour resembles that of *ancora* n. sp. except it is much more slender near the base, enlarging distally and ending in a slender recurved tip. A straight process projects into the hollow formed by the curve of the base of the shaft. (Pl. II, Figs. 16 and 16a).

Holotype, male; Culberson Co., Texas, July 10, 1927; R. H. Beamer. *Allotype*, female; *Paratypes*, females 7 and males 7, same data; 3 males, Gila Co., Arizona, August 5, 1927; R. H. Beamer; 1 female, Huachuca Mts., Arizona, August 1, 1927; R. H. Beamer.

Erythroneura illinoiensis (Gill.).

This beautiful species was taken commonly where wild grape occurred.

Erythroneura illinoiensis var. **regalis** var. new.

General ground color yellowish white. Vertex with a bright red triangular spot near middle, pronotum with a square spot near middle and scutellum with apex and a spot at each basal angle of same brilliant red color. Clavi marked with indefinite golden-yellow anchor in basal two-thirds and small spot of same color near tip. Coria marked with a sooty-black blotch of about the size and shape of costal plaque, located between cubitus and anal vein oposite costal plaque; a small sooty-black spot near posterior end of costal plaque and a larger spot of same color at base of cell M_4. Extreme tips of tegmina more or less fumose. Large red spot on side of mesothorax.

This variety may be separated from *illinoiensis* (Gill.) by the elongated black sooty patches on the corium.

Holotype, male; Oak Creek Canyon, Arizona, August 14, 1927; R. H. Beamer. *Allotype*, female and *Paratypes*, 7 females and 6 males, same data.

Erythroneura rubicunda n. sp.

Ground color white tinged with yellow. White markings of vertex arranged crosswise in two rows of three spots each, the center spot of each row connected forming a mesal logitudinal white mark. The outer spots roughly triangular and larger than the median ones. Between the white spots orange. Pronotum occupied by two large orange triangles except a white inverted T whose base separates these triangles. Base of the T between triangles enlarging anteriorly. Crossbar of T occupying entire base of pronotum. Each orange triangle with two definite white spots. Scutellum orange except a mesal rectangular spot near base and two lateral triangular spots. Tegmina with the following orange marks: clavus with a large basal spot touching claval suture on one side but not reaching inner margin, a median spot one of whose sides is on claval suture the other on inner margin, as long as broad, and a third smaller spot almost to tip. Corium orange to red throughout except an area about the costal plaque which reaches to claval suture between first and second claval spots, an area more or less irregular-sided beginning opposite last claval spot and running roughly parallel to cross-veins to radius which are white and apex of cells M and Cu which are fuscous. Costal plaques are white tinged with purple and more or less bordered with red on inner side. Cross-veins white. Beyond cross-veins fuscous. Face red with four white spots on anterior border. Three spots of the vertex also extend down on face. Length 2.7. mm.

Holotype, female; Pinal Co., Arizona, August 6, 1927; R. H. Beamer.

Erythroneura variabilis n. sp.

General ground color dark, varying from fumose through green to red, with the following light areas: on vertex white band on margin from eye to eye and three white spots connected with base by a narrower line; on pronotum three oval white spots slightly posterior to anterior margin with long axis logitudinal, in some specimens they tend to be longitudinal stripes, and two triangular areas on base either side of median line; on scutellum a median vitta more or less definite with lighter blotches either side of tip; tegmina, on clavus a large sinuate area bordering scutellum and crossing to or nearly to the claval suture near its middle, another diagonal spot two-thirds of distance to tip; on corium a definite area continuing from the last claval spot following cell Cu more or less interrupted, ending on margin of tegmen at tip of clavus, a more or less definite area beginning at posterior end of first claval area running diagonally to cell M following it almost to cross-veins; costal plaque yellowish white set off at either end by an oblique darker vitta. A yellowish-white spot between the posterior darker area and cross-veins. Cross-veins, cell R_1, base of cell R_3 and apex of cell M_4 light, remainder fuscous. Vein R_1 red.

Genitalia.—Pygofer hook a bifid process, the inner much shorter than the outer. It is this character which separates this species from *E. vulnerata* Fitch. (Pl. II, Figs. 20 and 20a).

The markings of this species, both light and dark, are exceedingly variable. The wing venation places it in the *vulnerata* group where it runs down to *vulnerata* Fitch, from which it is quite distinct according to the male genitalia. This is one of the common destructive species of Erythroneura on grape in Arizona.

Holotype, male, Yavapai Co., Arizona, August 9, 1927; R. H. Beamer. *Allotype*, female; Coconino Co., Arizona, August 18, 1927; L. D. Anderson. *Paratypes*, 400 males and females from various localities in Arizona.

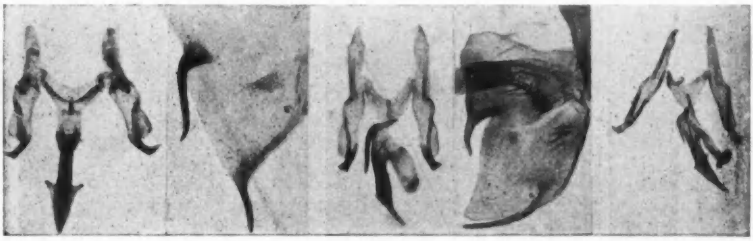
Erythroneura grandis n. sp.

General ground color yellowish white. Vertex red with the following yellowish white spots: a row of five connected spots on apex extending between the eyes, the lateral ones much smaller and a spot in each basal angle touching the eye. Pronotum dark red except basal third and several small spots along anterior margin. Scutellum dark red in holotype although the allotype has the basal angles slightly lighter. Tegmina to cross-veins brick red with the following light areas: a narrow cross band just posterior to tip of scutellum extending almost to costal margin, an irregular sided circle about red marks near tips of clavi, the apices of the sectors and in some specimens more or less of second sector. Cross-veins light. Beyond cross-veins dark with lighter areas. Costal plaque light creamy yellow splotched with purple and red. Venter fuscous, mesosternum bluish black, face red with the following light spots: a small spot above base of each antenna and an anteriorly projecting club-shaped spot between them. Length of female 3.7 mm.

Genitalia.—Pygofer hooks two. Oedagus broad in lateral view with a heavy base and upward projecting tip. A pair of processes arise at base of shaft bending out at right angles about one-fourth distance from tip.

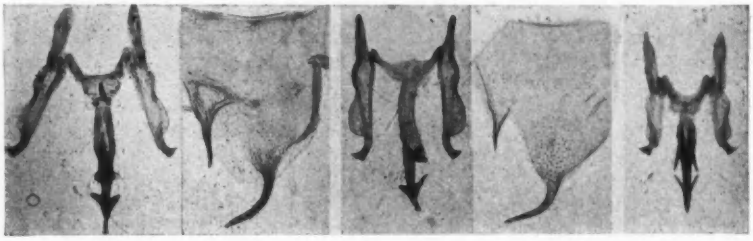
Holotype, male; Oak Creek Canyon, Arizona, August 14, 1927; R. H. Beamer. *Allotype*, female, same data. *Paratype*, male and female, same data. One male, Huachuca Mts., Arizona, August 1, 1927; R. H. Beamer.

This species has somewhat the same general appearance as *rubicunda* n. sp., but is about a third longer and has fewer white markings on pronotum and vertex.

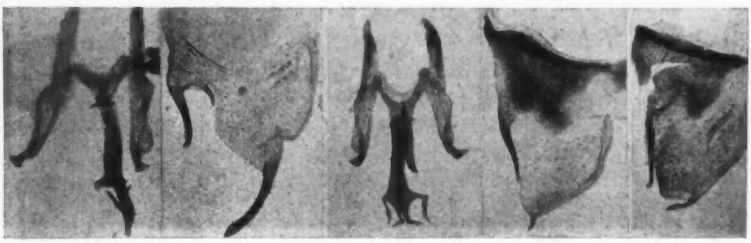


1. obscura *1a.* *2. canyonensis* *2a.* *3. nicholi*

4. pinalensis *4a.* *5. tripunctata* *5a.* *3a.*

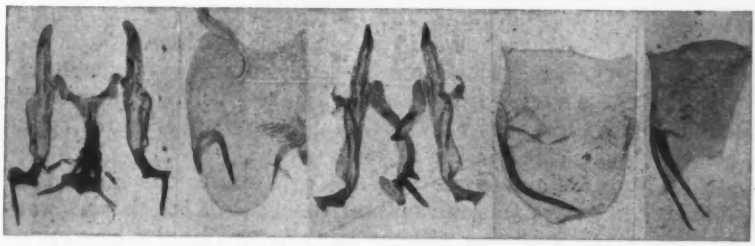


6. pallenta *6a.* *7. cimarroni* *7a.* *8. casta*

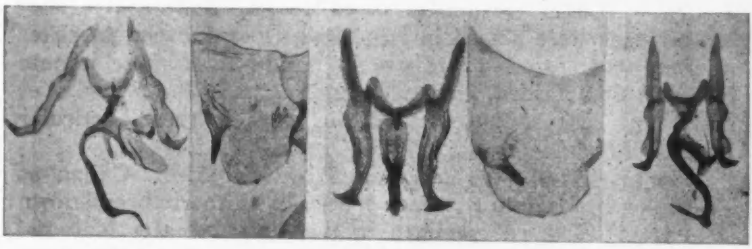


9. unicolor *9a.* *10. triceroprocta* *10a.* *8a.*

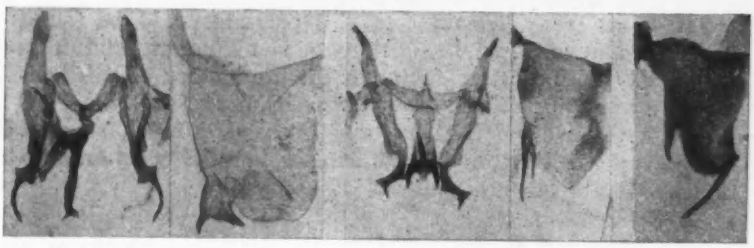
11. anzara *11a* *12. anfracta* *12a.* *13. carmini*



14. gilensis *14a.* *15. texana* *15a.* *13a.*



16. milleri *16a.* *17. illinoiensis* var. *regalis* *17a.* *18. tricolor*



19. kiperi *19a.* *20. variabilis* *20a.* *18a.*

A LEAFHOPPER PARASITE—POLYNEMA SAGA (GIRAULT).

(Hymenoptera, Mymaridae)

PAUL B. LAWSON,
University of Kansas, Lawrence, Kansas.

During the summer of 1927, the writer became interested in the life history of the leafhopper, *Euscelis stactogalus*, which was then unusually abundant on some tamarix bushes near the laboratory. The insects were actually numerous enough to discolor these very hardy plants quite seriously. Under such conditions, it was very easy to find a large number of the eggs, which are deposited in the newer stems.

While examining some of these eggs under the binocular, one day, a tiny parasite ran into the field of vision and was seen to oviposit in several eggs after first carefully examining them with its antennæ. This led to further observations and finally a number of tamarix twigs bearing hundreds of leafhopper eggs were placed in large test tubes and the parasites allowed to emerge. In this way, hundreds of these minute insects were obtained, for they seemed to have parasitized over ninety per cent of the overwintering eggs in these particular bushes.

The parasites were determined by Mr. A. B. Gahan as *Polynema saga* (Girault), which species has hitherto been known only from the type specimen in the United States National Museum. This specimen was taken by H. S. Barber at Washington, D. C., 31-7-05.

It seems fairly certain that this parasite could be found readily wherever *Euscelis stactogalus* is abundant, and it is apparently an important factor in the life history of this leafhopper, since due to the severe parasitism of 1927, the 1928 broods on the same bushes have been very much smaller. It will be interesting to bear this parasite in mind when examining the eggs of other species of leafhoppers.

THE INJURY TO NESTLING BIRDS BY THE LARVAE OF PROTOCALLIPHORA.

CHARLES W. JOHNSON,
Boston Society of Natural History.

The effect of the bloodsucking larvæ of Protocalliphora on nestling birds has heretofore received comparatively little attention. The habit of the larvæ of usually hiding in the nest by day and coming forth at night to feed upon the blood of their hosts, is undoubtedly the reason why they have escaped the attention of most ornithologists. To the entomologists the fly was usually considered rare as very few were taken by the ordinary methods of collecting. No one realized how abundant the flies really were until the actual breeding places of the flies were studied. Thus comparatively little progress has been made toward a knowledge of their habits since their injury to nestling birds was recorded near Boston twenty years ago.

Through the cooperation of a number of persons interested in bird-banding I have been making some studies on the effect of the larvæ of species of Protocalliphora on nestling birds. To further increase an interest in this work among the bird-banders and other bird lovers, my notes have been published in the Bulletin of the Northeastern Bird-Banding Association, and have thus probably escaped the attention of most entomologists. I will therefore briefly review the subject together with my notes for 1928.

In 1908 W. H. Henshaw recorded two successive broods of Bluebirds at Wellesley Hills, Mass., infested by the larvæ of Protocalliphora, in which seven of the eight nestling birds were destroyed. In 1915 Albert F. Coutant made a biological study of the Protocalliphora infesting the Common Crow and the Chipping Sparrow at Ithaca, N. Y. In 1919 O. E. Plath published some interesting papers on the occurrence and habits of Protocalliphora infesting some ten species of birds, in the vicinity of San Francisco, California and the Puget Sound region. He states that from five to ten per cent of the nestling birds die from the attacks of these parasites, while

others are so weakened by the loss of blood that they fall an easy prey to rapacious animals. In 1922 Prof. M. Bezzi published a paper on the species of Protocalliphora of Europe and North America.

In the above mentioned papers the flies were referred to the European species *Protocalliphora azurea* Fallen and *P. chrysorrhea* Meigen, but studies made by R. C. Shannon and I. D. Dobroscky in 1924 show the American species to be distinct. An interesting paper on the external parasites of birds by Irene D. Dobroscky appeared in 1925. The work was done at Ithaca, N. Y., and shows the nests of the Bluebird and House Wren, especially the former, badly infested by Protocalliphora.

In the Bulletin (Jan., 1927) above referred to, I published my notes for 1926. A Bluebird's nest received from A. W. Higgins, Rock, Mass., contained 154 larvæ and puparia of *Protocalliphora splendida* var. *sialia* Shann. and Dobr. Owing to unfavorable conditions in shipping, only 24 flies emerged and from 17 of the puparia 202 chalcids issued, determined by A. B. Gahan as *Mormoniella brevicornis* Ashm. Two of the five birds were weak and unable to leave the nest. A second Bluebird nest from J. D. Smith, Needham, Mass., contained 33 puparia from which emerged 21 flies, while four were parasitized by the above mentioned chalcid.

In 1927 through the kindness of Messrs. L. W. and J. D. Smith, I was able to examine the nests of seven Bluebirds and four Tree Swallows. Two nests each contained three dead Bluebirds and two nests each one dead Tree Swallow. The number of larvæ and puparia in the Bluebird nests varied from 14 to 130, a total of 387, an average of about 55 per nest. No chalcids were observed in two of the nests. The other nests showed parasitism varying from 31 to 88 per cent, an average of about 54 per cent. A small tachinid *Plectops pruinosa* Mall. was obtained from two of the Bluebird nests. The Tree Swallows' nests which were infested by the same Protocalliphora contained from 10 to 89 puparia, a total of 220, an average of 55 per nest, the parasitism occurring in these nests varying from 10 to 78 per cent, an average of 51 per cent.

An interesting nest was that of the Crested Flycatcher, representing a new host for *P. splendida sialia*. It was obtained by Mr. A. W. Higgins at Rock, Mass., June 30.

The maggots caused the death of two of the nestlings. Mr. Higgins counted 95 maggots, but when the box reached me some had escaped and I could count only 71. On July 14 and 15, 29 flies emerged, from the other 42 puparia no flies issued. No parasitism was noticed.

On July 19 Mr. Higgins sent me a Bluebird nest containing 111 puparia, from 13 of which flies emerged. From 48 flies failed to issue and 50 were parasitized by the above mentioned chalcid, a parasitism of 54 per cent. Following the parasites the nest became alive with fleas, *Ceratophyllus* sp.

The most interesting nest of the season was that of the Black-throated Blue Warbler, from Ashland, N. H., obtained by Mrs. R. B. Harding. There were 38 puparia in the nest, from which emerged 35 flies, (9 males and 26 females). All the flies were the typical *P. splendida* Macq. with no marked evidence of sexual dichromatism as advanced by Shannon and Dobroscky in 1924. While the pollinose covering on the thorax is less evident in the male than in the female, the abdomens in both are alike, grayish pollinose, with the last segment coppery. In *sialia* the entire body is a dark, shining blue.

Miss Helen J. Robinson of Brewer, Maine, reported the death of nestling Bluebirds, May 26, and Mr. Edward H. Forbush sent larvæ of Protocalliphora taken from a Bluebird's nest in a bird-box at North Middleboro, Mass. There were two dead birds in this nest.

In 1924 I obtained from Mr. J. S. Pfeil two maggots taken from swellings on the neck of a sparrow found near Middleboro, Mass. The larvæ pupated August 3, and the adults (a male and female) emerged August 12. This was recorded in 1925 as *Protocalliphora hirudo* var. *cuprea* Shann. and Dobr., and constitutes the only eastern record for the species. It was described in 1924 from Seattle, Wash., from the nest of a Western Robin.

During the summer of 1928 the following nests were examined. On June 18, a Bluebird's nest received from Mrs. E. L. Hathaway, of West Bridgewater, Mass., containing 58 puparia. Forty-one flies emerged and 16 puparia were parasitized by the chalcid mentioned, a parasitism of about 28 percent. On July 24 Mrs. Hathaway sent me the nest of the second brood of the Bluebird. When banding the nestlings

she had found four of the maggots clinging to the bird. There were two sizes of larvæ in the nest, but all apparently pupated, although 19 were quite small, due no doubt to underfeeding. The total number of puparia was 153. Flies emerged from 38, from 26 flies failed to issue, and 89 were parasitized, the total parasitism being about 58 per cent.

On July 7 a Barn Swallow's nest was received from Mrs. Karl G. Wormuth of Belmont, Mass. It contained 51 large maggots, which had probably driven the nestling birds from the nest during the night, as they were found dead in the morning on the floor of the barn. Only 39 flies emerged from the puparia. There was no parasitism. Mr. H. E. Woods reported Barn Swallows infested by Protocalliphora in 1925.

From the puparia in the nest of a Chestnut-sided Warbler collected near Ashland, N. H., Mrs. R. B. Harding obtained seven specimens of the typical *P. splendida*. From the puparia in the nest of a Robin also collected near Ashland, N. H., Mrs. Harding obtained 39 flies, apparently the same as those infesting the Bluebirds. In neither case did I see the puparia, so that parasitism, if present, could not be noted.

The above notes are sufficient to show that the larvæ of Protocalliphora are a serious menace to nestling birds and that measures should be taken to check their depredations. Parasitism is a factor in diminishing their number, but the percentage thus destroyed is at present considerably below what is called "Nature's balance." When nests are accessible, especially in bird houses, I would suggest that the first nests be destroyed as soon as the nestlings leave the nest. With the second brood however, it would seem best to wait about a month before destroying the nests, thus enabling the parasites to escape. There is usually a greater amount of parasitism in the second than in the first brood. There seems to be little doubt but that the adult female hibernates during the winter and in the spring oviposits in the nest when conditions are favorable for the young larvæ.

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1919a. **Plath, O. E.** Parasitism of Nestling Birds by Fly Larvae. Condor, vol. 21, pp. 30–39.

1919b. A Muscid Larva of the San Francisco Bay Region which Sucks the Blood of Nestling Birds. Univ. Calif. Publ. Zool., vol. 19, no. 5, pp. 191–200.

1919c. The Prevalence of Phormia azurea Fall in the Puget Sound Region and Data on Two Undescribed Flies of Similar Habits. Ann. Entom. Soc. Amer., vol. 12, pp. 373–381.

1922. **Bezzi, M.** On the Dipterous Genera Passeromyia and Ornithomusca with notes and Bibliography on the non-pupiparious Myiodaria Parasitic on Birds. Parasitology, vol. 14, pp. 29–46.

1924. **Shannon, R. C.** and **Dobroscky, I. D.** North American bird parasites of the genus Protocalliphora. Jour. Wash. Acad. Sci., vol. 14, pp. 247–253.

1925. **Dobroscky, I. D.** External Parasites of birds and the fauna of bird's nests. Biol. Bull., vol. 48, pp. 274–281.

1925. **Johnson, C. W.** List of New England Diptera. Occas. Papers, vol. VII, No. 15, Boston Soc. Nat. Hist., p. 217.

1926. **Woods, H. E.** A New Host for the Blood-sucking larva fly. Protocalliphora splendida. Bull. NE. Bird-Band. Assoc., vol. 2, p. 12.

1927. **Johnson, C. W.** The Infestation of Bluebirds' nests by Protocalliphora. Bull. NE. Bird-Band. Assoc., vol. 3, pp. 1–3.

1927. **Johnson, C. W.** Further studies of Protocalliphora infesting nestling birds. Bull. NE. Bird-Band. Assoc., vol. 3, pp. 77–81.

BOOK NOTICE

PRINCIPLES OF FOREST ENTOMOLOGY, By Samuel A. Graham, XIV + 339 pages, 149 figures. *McGraw-Hill Book Co.*, New York, 1928.

This is a book written primarily for teachers of forest entomology but will be of interest to economic entomologists, ecologists, foresters and to many others engaged in growing or utilizing forest products. It deals with the theory of forest preservation against insect attack, with situations and methods, giving a minimum of space to descriptions of injurious species of insects. C. H. K.

THE TEACHING OF MEDICAL ENTOMOLOGY*

WILLIAM A. RILEY,
Department of Zoology, University of Minnesota.

The teaching of a subject which is growing as rapidly as medical entomology cannot be reduced to a common formula. Even if such a standardization were possible, there is little basis for supposing that any real progress would result through it.

To be sure, there are in the educational world of today two counter currents as regards outlined courses. The one has as its goal standardized courses leading to uniformity and to ease of evaluation on academic records. The other leaves much to the initiative of the individual teacher, the course to be determined largely by his own conceptions of the subject and of the best methods of passing it on to his students.

My own belief is that the second tendency is the sounder, in so far as college courses are concerned. My efforts during the past fifteen years have not been directed towards the attempt to find ready-made or to develop a universally applicable course of medical entomology but rather towards the meeting of the needs of the groups of students with which I have come in contact. Each year impresses me with the diversity of these needs and with the difficulties involved in trying to meet them. Far from bringing discouragement, they add zest to the problem. It is, then, with the idea of opening up the subject rather than with any thought of outlining a model course, that I present some of the problems which I have encountered and indicate in broad outline the manner in which I have tried to meet them.

Granting that an independent general introductory course in medical entomology is to be given, several important questions must immediately be considered. What classes of students seek such a course and what is their preparation? What are

*A section of a symposium on "The Teaching of Parasitology," presented before the American Society of Parasitologists.

the broad outlines of such a course and what are some of the ways in which the work may be adapted to special groups?

When I was first called upon to present a course in medical entomology, I had the relatively simple problem of dealing with a group of advanced students, all of whom had a background of elementary zoology and of general entomology. The majority of them had had a considerable amount of training in the latter field. It was a stimulating group but not a typical one.

Very soon it became apparent that the importance of the rapidly growing field was attracting a very heterogeneous group. This seems to be the situation in most of the institutions in which the subject is now being developed.

In the first place, there are students of zoology and of entomology who wish to round out their regular courses by more detailed information regarding the revolutionary discoveries of the relation of arthropods to their symbionts and to disease of man and animals. A few of these have already decided that they wish to do advanced work in the subject. Others are looking forward to the teaching of entomology or to practical field work in insect control. In the same group will be a number of premedical and medical students interested because of the bearing of the subject on their chosen life work. Similarly, occasional health officers or social science workers may desire an introduction to the subject or even special training. What common background can be expected of such a class?

It would seem hardly necessary to say that a brief course in medical entomology of college grade cannot be given without a prerequisite of a thorough course in general zoology. In the few schools where it is still believed that entomology is a subject apart and can be presented without a background of zoology, the training already gained in systematic entomology will permit of substitution in the way of elementary zoology but under such conditions it is exceedingly difficult to give a balanced course in the subject.

Beyond the general zoology, there will still be great diversity of preparation and whenever it is possible the students should be grouped in special sections. This is not feasible under conditions prevailing in most institutions. Assuming that the students are to be handled in a single class and have only a zoology prerequisite, there are certain basic needs to be met in the presentation of the subject.

The student must know that names and characteristics of the chief arthropod groups with which he is to deal, and the general position of the phylum.

He must know sources of information, not merely a single text, however good, but the various available texts and, by all means, methods of getting at the original contributions to the subject. However exaggerated the statement may be that texts are books in which we embalm truths, it must nevertheless be recognized that in a rapidly growing field of knowledge no one who ignores the current literature can rank as a scholar. One of the most important duties of a teacher is to impress this fact upon his students.

On the other hand, the student must gain an appreciation of the pioneer work in medical entomology and of its bearing upon present and future work. The teacher of medical entomology or of any phase of science needs often to remind himself and his students of Emerson's statement that "coming Time already waits unseen yet definitely shaped, predetermined and inevitable in the Time come; and only by the continuation of both is the meaning of either completed."

Following this introductory material the course may take up in systematic order the poisonous and the simple parasitic arthropods emphasizing in so far as time will permit, their morphology, life histories and general biology, their effects on man and animals, sources of infestation, and methods of offense and defense against them. In this connection mention should be made of their role as transmitters of diseases but I prefer to take up the details of that aspect of the subject later, discussing the various insect-borne diseases, their causative organisms, the manner in which they are conveyed and the methods by which they have been, or may be controlled.

Finally, there is given a résumé of the advances already made, the present day status of the problems and of the outlook for the future.

The course combines lecture, recitation, and laboratory work. At the first lecture period the students are given a list of the major groups which are to be most frequently mentioned. This is by way of review for it has already been presented in the course in General Zoology. Needless to say, it appears wholly new to most of the class—the examinations are passed and who ever suspected that there would be any

further use for such details? By way of emphasizing the review two early laboratory periods are devoted to determining an assortment of arthropods to classes, and a considerable number of insects to orders.

One or more laboratory periods, and assignments throughout the term are devoted to becoming acquainted with source material in the literature. There are placed before the student significant copies of the leading journals of importance to the worker in medical entomology. Similarly, he is made acquainted with the publications of the United States Public Health Service, the Bureau of Entomology, and the Bureau of Animal Industry. Particular attention is given to the abstract journals in English, French and German, and to such aids as the Index Medicus, Quarterly Cumulative Index, the Catalogue of the Surgeon General's Library, and the Zoological Record. Assigned topics give practice in the use of these various publications.

For the historical aspects the student is encouraged to look up the original reports of epoch-making discoveries and to read contemporaneous comments and criticisms which these reports aroused. So new is the field that any good university library will afford opportunities for such reading—a medical collection will broaden the opportunity, but even a good public library will offer much of value. Old files of Harpers Weekly, the North American Review, and other secular magazines well repay browsing. Incidentally, I suggest also the reading of some of the great historical novels such as Manzoni's "The Betrothed," Ainsworth's "Old St. Paul's,' Charles Brockton Brown's "Arthur Merwyn," and Defoe's "Journal of the Plague Year" which have their setting in periods of great epidemics.

Beyond the preliminary very general work in classification the laboratory work affords opportunity for getting acquainted with the mature and immature stages of the principal forms of importance but no attempt is made to drill the students in special taxonomy. If such training is desired it is afforded in other courses.

It is very desirable to require a preliminary course in the principles of animal parasitism, in which considerable stress is put upon the parasitic protozoa and the helminths. In case the class has not that preparation, a study is made not only of vectors, but important pathogens, such as living and stained trypanosomes, malarial parasites, filariæ, and cestode larvæ

dependent upon insects. Whenever feasible, forms parasitizing domesticated and feral animals are used.

Such a course as I have broadly outlined is designed as a survey course. The student with a good background of general zoology, entomology, and supporting subjects and with a fairly definite plan of work should be treated individually and given opportunity for such special preparation as may seem most advantageous. This may take the form of special taxonomic or life history or ecological work on the mature or immature forms of arthropods of medical importance, or of their parasites and their relations to these, or it may be any one of the many special problems.

If he has in mind preparing himself for special work in medical entomology, he will probably find the survey course a helpful introduction but it is essential that he be impressed immediately by the breadth of the field. Its scope is a wide one and touches upon very many of the most rapidly growing phases of pure and applied biology. No longer can the systematist trained in the determination of larval and adult mosquitoes qualify by that alone as a medical entomologist. The field worker who can locate the breeding places of mosquitoes and distinguish the anophelines in their various stages is indespensable, but if he wishes to be more than a technician he soon learns that medical entomology demands other preparation and interests. The day is long past when a worker could dip a housefly into a culture of bacteria, transfer it to a sterile plate and seriously suggest that he had thereby established the fact that these insects played an important role in the transmission of disease.

He must be impressed, then, by the necessity for broad fundamental preparation. As early as possible in his course he should get his equipment of modern languages—a need all too often overlooked until the crowded days of graduate work. His zoological training should include not only entomology but ecology, experimental zoology, protozoology, and helminthology. Bacteriology, histology and pathology are supporting subjects of great importance. If one is to do sound research work on the insect vectors of the parasitic protozoa it is essential that he have a thorough knowledge of the normal anatomy and histology of his subjects. The zoological work mentioned presupposes training in chemistry and biochemistry

but it is well to emphasize especially the need of preparation along these lines and in general physiology for the man who plans to take up serious work in medical entomology. The training in general botany should, if possible, be supplemented by courses in mycology and in plant pathology for these open up border-line fields of growing significance to the animal parasitologist. Of the many other subjects which will bear upon his work, one which is in danger of being overlooked but which is becoming an essential tool of the biologist is that of biometry. Advantage should be taken early of any opportunity to add this to the courses elected.

To attempt to list the subjects which would be of use to the prospective research worker would be an absurdity. The business of medical entomology as Alcock has expressed it, "is, in the case of any species convicted on pathological evidence of being a standing danger to the public health, to unriddle its biology in every detail, and to investigate all the varying circumstances that influence its acquisition and retention of pathogenic capacity." A broad contract it is and one which challenges the best training which a man can bring to it. Fortunate is the teacher who can leave with his students this conception rather than merely a mass of data of presumably immediate applicability.

EUGENE AMANDUS SCHWARZ

Dr. E. A. Schwarz, an Honorary Fellow of the Entomological Society of America, died in Washington on October 15, 1928, at the age of eighty-four years and six months. Of that long life, fifty-five years were spent in this country, and more than fifty of those years in the service of the United States government. Doctor Schwarz was made an honorary member of the Entomological Society of America in 1914. He had for a long time been the only honorary member of the New York Entomological Society. In 1916 he was made Honorary President for life of the Entomological Society of Washington, after an amendment to the constitution had been adopted creating this honorary office. In 1923, the University of Maryland made him Doctor of Science. (*honoris causa*). In August, last, the Fourth International Congress of Entomology, meeting at Ithaca, sent him a special telegram of greeting and respect.

Doctor Schwarz was born at Liegnitz, Silesia, April 21, 1844. As a boy he became interested in entomology and later was a student at the University of Breslau. After the Franco-Prussian War, he was a student for some time at the University of Leipzig. In December, 1872, he came to the United States and became an assistant to H. A. Hagen at Cambridge, Mass. In 1874 he went with H. G. Hubbard to Detroit where they founded the Detroit Scientific Association and built up a collection of insects. With Hubbard he made explorations in Florida and in the Lake Superior region, and published papers on the Coleoptera of those regions.

In the summer of 1878, on recommendation of Dr. J. L. LeConte, he was taken on as an assistant to C. V. Riley in Washington in the closing work of the U. S. Entomological Commission. On November 15, 1878, he was definitely appointed an Assistant in the U. S. Department of Agriculture. He remained with the Department of Agriculture until August 27, 1926, when he was pensioned and retired for age.

For many years previous to his retirement he had been Custodian of the Coleoptera in the U. S. National Museum and, although paid by the Department of Agriculture, his work was done mainly in the Museum. After his retirement he continued his Museum work.

Doctor Schwarz was one of the most learned entomologists in the United States. He was an exceedingly close observer, a great collector, and a very broad student of entomology, attracted to both the taxonomic and the biological sides of the study of insects. He was a great mine of information and was consulted by younger men all the time. In the course of his more than fifty years at Washington, he made many expeditions both privately and officially. In these expeditions he covered practically all parts of the United States, and also spent some

EUGENE AMANDUS SCHWARZ

months in Panama, Guatemala, Mexico and Cuba. One of his expeditions also took him into British Columbia. He published no *magnum opus*, but very many short papers, all of great merit. He shunned publicity, and yet he was known among the entomologists of this country, and of other countries as well, as a man of very great learning and of the highest standing. His influence on the character of American entomology was very great. He was one of the kindliest souls that ever lived, and hundreds of younger workers have acknowledged their gratitude to him for help that he had given them. It was the custom of entomologists for many years when visiting Washington to consult him about their troubles.

In 1926 he had a slight stroke, and from that time on was not able to express himself coherently. Although he remained apparently unimpaired in intellect, his decline dated from that time.

The Entomological Society of Washington has devoted the December, 1928, number of its Proceedings to his memory, and that part contains a long memorial sketch by H. S. Barber, A. Busck and the writer, a map of Doctor Schwarz' collecting trips and a bibliographical list compiled by Miss M. Colcord.

L. O. Howard.

PROCEEDINGS OF THE TWENTY-THIRD ANNUAL MEETING.

New York, N. Y., December 27th and 28th, 1928.

The twenty-third annual meeting of the Entomological Society of America was held at New York, December 27th and 28th, 1928. The program covered a large variety of topics and included many interesting and important contributions. The attendance ranged from 60 to 110, with a total of approximately 180 members present at one or more sessions.

The Annual Public Address was delivered by Dr. Royal N. Chapman. Doctor Chapman's address, entitled, "The Potentialities of Entomology," was greatly appreciated and thoroughly enjoyed by everyone present. The symposium, "Present Trends in Systematic Entomology," which was presented by C. T. Brues, W. T. M. Forbes, J. A. Hyslop, J. C. Bequaert, J. A. G. Rehn, and J. N. Aldrich, was well received and aroused much interest.

Opening Session, Thursday Morning, December 27th.

The Society was called to order at 10:45 A. M., by President E. O. Essig, in Room 411, Main Hall, Teachers College, Columbia University, New York. Attendance, 100. The following papers were presented:

1. Sentiment in Entomology. E. O. Essig, University of California.
2. Early Official Entomologists in New York State and Their Work. E. P. Felt, Bartlett Research Laboratory.
3. The Brooklyn and New York Entomological Societies, Past and Present. G. P. Engelhardt, Brooklyn Museum.
4. A Method for Obtaining Ecto-Parasites of Birds and Mammals. W. E. Dove, U. S. Bureau of Entomology.
5. The Injury to Nesting Birds by the Larvæ of Protocalliphora. Chas. W. Johnson, Boston Society of Natural History.
6. Soil Animals Injurious to Sugarcane Roots. Herbert Spencer and Charles L. Stracener, Louisiana Agricultural Experiment Station.
7. Biology of Plecoptera. P. W. Claassen, Cornell University.
8. Some Experiments with Insects. Frank E. Lutz, American Museum of Natural History.
9. A Season's Leafhopper Collecting at Trap Lights. Paul B. Lawson, University of Kansas.
10. New Genera and Subgenera from the Genus Deltocephalus. D. M. DeLong and J. P. Sleesman, Ohio State University.
11. Larval Structure in the Dryopidæ. Luther S. West, Battle Creek College.

The following committees were appointed by President Essig:

Nominating Committee—F. E. Lutz, Chairman; E. P. Felt, H. Osborn.
Auditing Committee—C. J. Drake, Chairman; J. S. Houser, B. A. Porter.
Resolutions Committee—D. M. DeLong, Chairman; J. M. Aldrich, P. B. Lawson.

Moved and carried that DOCTOR FELT'S photograph be included with the other New York entomologists, if DOCTOR FELT'S paper, presented at this session, is published.

Second Session, Thursday Afternoon, December 27th.

The Society was called to order at 1:35 P. M. Attendance, 100. The following symposium was presented:

PRESENT TRENDS IN SYSTEMATIC ENTOMOLOGY.

Introductory Remarks.....C. T. BRUES
1. Nomenclature.
   a. Scientific Names.....W. T. M. FORBES
   b. Common Names.....J. A. HYSLOP
2. Descriptions.....J. C. BEQUAERT
3. Modern Methods of Making and Preserving Collections.....J. A. G. REHN
4. Museums and Depositories.....J. M. ALDRICH

Concluding Remarks.....C. T. BRUES

Third Session, Friday Morning, December 28th.

The Society was called to order at 10:00 A. M. The following papers were presented:

12. Senses of Lepidoptera. N. E. MCINDOO, U. S. Bureau of Entomology.
13. The Pedipalp Sense Organ of the Solpugid *Eremobates sulphurea*. HELEN E. MURPHY, University of New Mexico.
14. On the Bionomics of a Primary Parasite and of Two Hyperparasites of the Geranium Aphid. GRACE H. GRISWOLD, Cornell University.
15. *Aphelinus mali* and Its Travels. L. O. HOWARD, U. S. Bureau of Entomology.
16. Some Erythroneura (Homoptera-Cicadellidæ) from the Southwest. R. H. Beamer, University of Kansas.
17. The Taxonomic Value of the Embolus in the Erigoneæ. C. R. CROSBY, Cornell University.
18. High Altitude Syrphidæ (Diptera) from Pingree Park, Colorado, with Descriptions of New Species. CHAS. L. FLUKE, JR., University of Wisconsin.
19. The Folded-Winged Wasps of the Bermudas, with some Remarks on Insular Wasp Faunas. JOS. BEQUAERT, Harvard Medical School.
20. Notes on Coleoptera Taken from Bait Pails. S. W. FROST, Pennsylvania Agricultural Experiment Station, and HENRY DIETRICH, Appleton, N. Y.
21. Notes on the Coleoptera Fauna of Western Washington, with the Record of Four Introduced European Carabidæ. MELVILLE H. HATCH, University of Washington.
22. Some Facts Relative to the Effects of High Frequency Radio Waves on Insect Activity. THOMAS J. HEADLEE, New Jersey Agricultural Experiment Station.
23. Surgical Shock of Insects and Recovery. WM. ROBINSON, University of Minnesota.
24. Absolute Humidity as a Factor in Insect Hardiness. NELLIE M. PAYNE, University of Pennsylvania.

Fourth Session, Friday Afternoon, December 28th.

The Society was called to order at 1:30 P. M. Attendance, 65. The following program was presented:

25. Studies in the History of Coleopterology from Aristole to Linnaeus. MELVILLE H. HATCH, University of Washington.

26. The Detection and Estimation of Insect Chitin and the Irrelation of Chitinization to Hardness and Pigmentation of the Cuticula of the American Cockroach. F. LESLIE CAMPBELL, U. S. Bureau of Entomology.
27. The Mating Flight and the Vestigial Structure of the Mayfly, *Campsurus*. ANN H. MORGAN, Mount Holyoke College.
28. The Metamorphosis of a Mid-Intestinal Gland (Chrysomelidæ). WILLIAM C. WOODS, Kent School.

The Annual Business Meeting followed the reading of papers, as follows:

REPORT OF THE SECRETARY.

Previous to July 1, 1928, the following, having been duly nominated and recommended, were elected members of the Society by mail ballot of the Executive Committee:

T. E. ADKINS, 309 Aztec Bldg., San Antonio, Texas.
F. F. BIBBY, Agricultural Experiment Station, A. & M. College, College Station, Texas.
DONALD JOYCE BORROR, 149 W. Park St., Westerville, Ohio.
THEODORE H. BURRIS, Route B, No. 10, Ballinger, Texas.
FRANK D. DEGANT, 3401 Wade Ave., Cleveland, Ohio.
FREDERICK COURTNEY GILLIATT, Entomological Laboratory, Annapolis Royal, N. S., Canada.
LYSBETH LOUISE HAMILTON, Department Zoology, University of Pittsburgh, Pittsburgh, Pa.
J. R. HILTZ, 240 Florence Ave., Pontiac, Mich.
J. W. INGRAM, Box 164, Crowley, La.
RALPH R. MILLER, Department of Entomology, Ohio State University, Columbus, Ohio.
S. A. RIFENBURGH, 246 Marstellar St., W. Lafayette, Ind.
JAMES NEVILLE RONEY, Division Entomology, College Station, Texas.
MINNIE B. SCOTLAND, 42 Continental Ave., Cohoes, N. Y.
IVAN SHILLER, 309 Aztec Bldg., San Antonio, Texas.
ALFRED WEED, 625 Mendota Court, Madison, Wis.

With the approval of the Executive Committee, Dr. Royal N. Chapman was invited to give the annual public address of the Society at the New York meeting. It was also decided to hold a symposium on the subject, "Present Trends in Systematic Entomology."

Wm. Moore, E. P. Felt, F. E. Lutz, W. T. Davis, and H. B. Weiss kindly consented to act as local representatives for the New York meeting.

The Executive Committee met at 4:30 P. M., December 27, in Room 415, Dodge Hall of Teachers College, the following members being present: E. O. Essig, Edith M. Patch, W. D. Funkhouser, H. Osborn, C. H. Kennedy, and J. J. Davis. P. P. Calvert and J. A. G. Rehn, appointed by the president to act for absent members, were also present.

The following Members were elected:

BERNARD A. APP, 67 N. Liberty St., Elgin, Ill.
REGINALD E. BALCH, N. Y. State College of Forestry, Syracuse, N. Y.
OLUS L. BARNES, 362 N. Third Ave., Phoenix, Ariz.
RALPH E. BARRETT, Department of Entomology, University of California, Berkeley, Calif.
J. A. BERLEY, Division Entomology, Clemson College, South Carolina.
IRA WESLEY BERRYHILL, U. S. Department of Agriculture, McAllen, Texas.
RALPH A. BLANCHARD, 600 Twenty-sixth St., Sacramento, Calif.
WILLIAM E. BLAUVELT, 214 Thurston Ave., Ithaca, N. Y.
ARTHUR LOUIS BRODY, Department of Entomology, Cornell University, Ithaca, N. Y.

FREDERICK MARTIN BROWN, Avon College, Avon, Conn.
M. BRUNSON, Picayune, Miss.
H. G. BUTLER, Entomology Laboratory, Wyoming, Del.
FRANK LESLIE CAMPBELL, Bureau Entomology, U. S. Department of Agriculture, Washington, D. C.
THOMAS P. CASSIDY, Box 1896, Tucson, Ariz.
ANDREW J. CHAPMAN, Tallulah, La.
ARTHUR C. COLE, JR., 2644 Medary Ave., Columbus, Ohio.
CLARENCE ARTHUR CROOKS, P. O. Box 976, Sandusky, Ohio.
S. E. CRUMB, Box 233, Puyallup, Wash.
TRABER NORMAN DOBBINS, Montrose, Miss.
FRED O. DODD, R. R. No. 5, Paris, Ill.
MELVIN HAZELTON DONER, Department of Entomology, University of Wisconsin, Madison, Wis.
NELSON L. DOUGLASS, P. O. Box 613, Grenada, Miss.
WILLIAM ALVIN DOUGLAS, Cut Off, La.
W. E. DOVE, Box 208, Dallas, Texas
WALTER H. DOVE, Department of Entomology, Ohio State University, Columbus, Ohio.
VERDA DOWDLE, Utah Agricultural College, Logan, Utah.
ERASTUS W. DUNNAM, Tallulah, La.
OTIS E. GAHM, 151 W. Eleventh Ave., Columbus, Ohio.
JOHN T. GAMBLE, 118 Shenango St., Greenville Pa.
ROBERT M. GEIST, 811 Euclaire Ave., Columbus, Ohio.
GWYNN L. GARRISON, Tallulah, La.
DILLARD WISTER GRIMES, P. O. Box 125, Durant, Miss.
JOSEPH PORTER HARRIS, Union Trust Co., Cleveland, Ohio.
THOMAS VINCENT HENNEBERRY, P. O. Box 976, Sandusky, Ohio.
JENNINGS RUSH HICKMAN, Department of Biology, State Normal College, Ypsilanti, Mich.
NAOMICHI INABA, 207 Harajiku, Sendagayamachi, Tokyo, Japan.
LYDIA A. JAHN, Department of Entomology, Ohio State University, Columbus, Ohio.
LUTHER G. JONES, Drawer 359, Monroe, Mich.
REGINALD MAX JONES, Science Bldg., Ames, Iowa.
WILLARD V. KING, Mound, La.
J. P. KISLANKO, P. O. Box 334, Wiggins, Miss.
JOHN FRANKLIN LAMIMAN, 201 Agr. Hall, University of California, Berkeley, Calif.
HORACE LANCHESTER, 708 E. A St., Moscow, Idaho.
MORTIMER DAMAREST LEONARD, Tobacco By-Products and Chem. Corporation, Louisville, Ky.
HARVEY J. MACALONEY, N. E. Forest Expt. Station, Amherst, Mass.
AUBREY H. MACANDREWS, College of Forestry, Syracuse, N. Y.
GEORGE A. MALONEY, Tallulah, La.
GEORGE E. MARVIN, 1532 University Ave., Madison, Wis.
CHARLES C. B. MAYER, Department of Entomology, Ohio State University, Columbus, Ohio.
DAVID FRANKLIN MILLER, Department of Entomology, Ohio State University, Columbus, Ohio.
CARL OTTO MOHR, State Entomologist's Bldg., Urbana, Ill.
R. W. MORELAND, Tallulah, La.
W. F. MOROFSKY, Department of Entomology, E. Lansing, Mich.
HELEN E. MURPHY, University of New Mexico, Albuquerque, N. M.
RALPH B. NEISWANDER, 713 Center St., Ironton, Ohio.
RICHARD CARL NEWTON, Fernald Hall, M. A. C., Amherst, Mass.
ANDREW R. PARK, JR., State Natural History Survey, Urbana, Ill.
JOHN OSCAR PEPPER, Experiment Station, State College, Pa.
CHARLES CARLTON PLUMMER, Department of Entomology, University of New Hampshire, Durham, N. H.
HAROLD KAUFFMAN PLANK, Trop. Plant Research Found., Cent. Baragua, Prov. Camaguey, Cuba.

WILLIAM PROCTOR, Bar Harbor, Maine.
ARGYLE B. PROPER, 17 E. Highland Ave., Melrose Highlands, Mass.
EDWARD AVERY RICHMOND, 201 Elm Ave., Riverton, N. J.
HERALD K. RIPPEY, 27 Russell St., Box 547, West Lafayette, Ind.
RAIFORD A. ROBERTS, P. O. Box 208, Dallas, Texas.
WILLIAM BRICE ROBERTS, 239 S. Fifth Ave., Mt. Vernon, N. Y.
GEORGE SALT, Farnham House Laboratory, Farnham-Royal, Bucks, England.
PAUL DELEON SANDERS, University of Maryland, College Park, Md.
STANLEY SUMPTER SHEFFIELD, A. & M. College, Miss.
LESLIE HAROLD SHROPSHIRE, Fayette, Miss.
EDOUARD HORACE SIEGLER, U. S. Bureau of Entomology, Washington, D. C.
JAY P. SLEESMAN, Department of Entomology, Ohio State University, Columbus, Ohio.
CLIFTON H. SMITH, Hooper, Utah.
GEORGE L. SMITH, Tallulah, La.
H. D. SMITH, European Parasite Laboratory, Domaine du Mont Fenouillet, Hyeres, (Var.), France.
GEORGE EDWARD SPENCER, 36 E. Central Ave., Moorestown, N. J.
A. E. STENE, Bur. Ent., State Department of Agriculture, Kingston, Rhode Island.
W. A. STEVENSON, Box 1896, Tucson, Ariz.
MARSHALL W. STONE, P. O. Box 297, Alhambra, Calif.
WILLIAM ERNEST STONE, Box 549, Sanford, Florida.
CHESTER A. SWINGARD, 467 Blvd., Logan, Utah.
ERNEST ROBERT TINKHAM, Box 242, Presidio, Texas.
LEE HILL TOWNSEND, Department of Entomology, University of Illinois, Urbana, Ill.
GEORGE SHERLOCK TULLOCK, Bussey Institution, Forest Hills, Mass.
MARGARET WINDSOR, 701 Michigan Ave., Urbana, Ill.
DAVID LONZO WRAY, JR., University of South Carolina, Columbia, S. C.
J. M. YEATES, Tallulah, La.
HIRAM C. YOUNG, Box 1896, Tucson, Ariz.

R. W. HARNED, by payment of $50.00, was transferred to life membership.

The following members have died during the year:

GUSTAV E. BENSEL, April 2, 1928.
JUAN BRETHES, July 2, 1928.
CHARLES LOUIS FOX, March 1, 1928.
CHARLES W. HOWARD, March 1, 1928.
JACOB KOTINSKY, December 28, 1927.
JEROME MCNEILL, August 30, 1928.
*EUGENE AMANDUS SCHWARZ, October 2, 1928.

The following members resigned during the year:

H. K. Adams C. K. Arter, L. J. Bottimer, Floyd Brimley, H. F. Carter, R. W. Deveson, F. I. Else, P. B. Fuller, Forrest Garner, Geo. Hofer, A. D. Hopkins, A. J. Kistler, N. W. Lermond, F. C. Nelson, E. J. Oslar, H. E. Roberts, M. G. Rodriguez, Robt. Schmaltz, R. H. Smith, R. D. Spencer. Total 19.

The following persons have been dropped from the Society roll, either because of non-payment of dues for three years or more, or because of failure to reach them:

L. S. Barber, D. M. Bates, J. A. Beal, Samuel Blum, W. W. Bowen, R. B. Cowles, J. C. Crawford, G. M. Decherd, Jr., G. E. Emery, L. V. France, Arthur Frank, C. L. Frankenfield, Lula G. Fritz, J. R. Furr, Horace Gladney, P. A. Glick, G. H. Hammond, C. B. Hardenberg, R. J. Harrington, Paul Herbst, J. D. Humphries, E. H. Ingersol, G. J. Keller, Quinta C. Kessel, Paul Knight, Raoul M. May, J. E. McEvilly, E. A. McMahon, W. M. Morris, T. J. Naude, P. R. Orr,

*Honorary Fellow.

J. T. Potgieter, W. V. Reed, J. A. Reis, Theresa M. Robinson, W. A. Ruffin, Fred Schwarz, H. E. Summers, Cho Teranishi, R. O. Wahl, C. E. White, S. D. Wilcox, Fo Ching Woo. Total 44.

Members	741
Fellows	92
Honorary Fellows	5
Total Net Membership, December 28, 1928	838

The following members were elected to fellowship by the Executive Committee:

F. C. Bishopp, R. J. Tillyard, J. R. de la Torre Bueno, H. E. Ewing, A. B. Gahan, Robt. Matheson, H. S. Barber, A. C. Kinsey, H. Morrison, H. H. Knight, Alvah Peterson.

Nathan Banks and E. C. VanDyke were elected members of the Thomas Say Foundation, to succeed themselves.

The following were elected members of the Editorial Board of the ANNALS for the term expiring December, 1931: C. P. Gillette, R. N. Chapman and Franklin Sherman.

The Treasurer reported receipt of $1,000.00 as a bequeath from the estate of Miss Mary E. Soule, sister of our late member, Caroline E. Soule. The money was transferred to the permanent fund.

Herbert Osborn, editor of the ANNALS since its first issue, offered his resignation and C. H. Kennedy, who has acted as assistant editor for several years, was elected editor.

It was moved and carried that the Executive Committee extend to Professor Osborn a vote of thanks for his long and valuable service as managing editor of the ANNALS and that his name appear on the ANNALS as Editor Emeritus.

Moved and carried that a permanent committee of three, including the Secretary, be appointed by the President, this committee to be known as a committee on co-ordination and to function with a similar committee of the American Association of Economic Entomologists.

Respectfully submitted,

J. J. DAVIS, *Secretary.*

On motion the Secretary's Report was accepted.

REPORT OF THE TREASURER.

CURRENT FUNDS.

RECEIPTS.

Balance, December 28, 1927. (See Annals, XXI, p. 159)	$4,333.09
From Annual Dues of Members	2,554.20
From Managing Editor of the Annals	700.00
Interest on bonds and savings balance	84.67
Total	$7,671.96

EXPENDITURES.

Printing Annals, December, 1926–September, 1928, inclusive, (two years), including separates	$5,259.75
Exchange on Checks	2.55
Printing 1927 Programs	29.50
Refund on Checks	6.20
Letterheads, Notices, Account Blanks, Envelopes, etc.	64.34
Clerical Service	60.00
International Congress of Entomology	150.00
Stamps and Stamped Envelopes	45.08

Miscellaneous, Including Telegrams, Refunds, etc	4.09
Total	$5,621.51
Balance, Cash on Hand, Purdue State Bank, December 20, 1928	2,050.45
	$7,671.96

LIABILITIES.

The Society owes the publishers of the Annals for the December, 1928, issue, and about $30.00 for programs. Since the books were closed, $655.53 has been received from the Managing Editor of the Annals and at least $100.00 from members for 1929 dues.

PERMANENT FUND.

The Society holds United States and Canadian Liberty Bonds, total, $700.00. (See Annals XXI, p. 159). Of these, $350.00 became due and were cashed in December, 1928, this amount being added to the bank account, making a total of $800.00 in the bank. To this amount has been added $1,000.00 bequest from the estate of Miss Mary E. Soule and one $50.00 life membership. The Permanent Fund during the past year has increased from $1,150.00 to $2,200.00, an increase of $1,050.00.

TOTAL RECEIPTS TO PERMANENT FUND.

Liberty Bonds	$ 350.00
Bequest from Estate of Miss Mary E. Soule	1,000.00
One Life Membership (R. W. Harned)	50.00
In Purdue State Bank	800.00
Total	$2,200.00

Respectfully submitted,

J. J. DAVIS, *Treasurer.*

On motion the Treasurer's Report was accepted, subject to the approval of the Auditing Committee.

REPORT OF THE MANAGING EDITOR OF THE ANNALS.

I have the pleasure of reporting a prosperous year for the Annals with the largest volume in its history and I believe a most creditable list of papers. The grant of $500.00 from the National Academy of Science for publication of research papers, with income from sale of back numbers, has made possible this large volume. Papers now in hand will more than fill the March number and we may expect as large a volume for the coming year.

As this will be the last volume under my charge, it may be permissible after 21 years as Managing Editor to review very briefly the growth of the Annals. Starting with a volume of 293 pages in 1908, the growth has been almost unbroken except for a short period during the World War, until we have this year a volume of 700 pages. There has been also a very steady growth in the subscription list, both in member and non-member subscription, and the Annals now goes to over 30 different countries, to every state in the United States but one, to Porto Rico, Hawaii, Canal Zone and Philippines, and is to be found in all the principal libraries of the United States and in many other countries.

It is hardly necessary to say that after these years of work with the Annals that I cannot escape a feeling of regret in dropping it. It has brought many pleasant associations and I shall remember with much pleasure the host of friendly contacts connected with it. I trust it may be a permanent contribution to entomological science and I feel assured that it will be maintained with increasing excellence as its opportunities widen and its resources continue to grow.

We are indebted this year as heretofore, to many authors for assistance in furnishing illustrations, especially to the Colorado Experiment Station for the beautiful colored plate in No. 1, and to the National Academy for its generous

grant to aid in publication. I am personally much indebted to Doctor Kennedy for assistance in the arduous duties of accounting and mailing.

The financial summary follows:

RECEIPTS.

Non-member subscriptions	$ 618.64
From sale of back volumes and numbers	361.82
Engravings and reprints	565.54
Grant from National Academy of Science	500.00
	$2,046.00

DISBURSEMENTS.

Mailing charges and postage stamps	$ 89.79
Stenographic and clerical service	171.00
Engraving bills and incidentals	429.68
Remitted to Treasurer	1,355.53
	$2,046.00

Vouchers for the expenditures are submitted herewith.

Respectfully submitted,

HERBERT OSBORN, *Managing Editor.*

On motion the report of the Managing Editor of the Annals was accepted, subject to the approval of the Auditing Committee. A rising vote of thanks was offered Professor Osborn for his long service and loyal support to the Society.

A brief informal report was made by J. M. Aldrich, Editor of the Thomas Say Foundation.

REPORT OF THE TREASURER OF THE THOMAS SAY FOUNDATION.

FOR THE YEAR 1928.

RECEIPTS.

Balance on hand January 1, 1928. (See Annals XXI, p. 160)	$ 21.61
Sale of Vol. I—5 @ $3.00	15.00
1 @ 3.15	3.15
Received from 1927 sale	3.00
Due on volume delivered, $3.00.	
Sale of Vol. II—6 @ $5.00	30.00
5 @ 4.50	22.50
1 @ 5.40	5.40
Received from 1927 sale	14.95
Total Receipts	$115.61

EXPENDITURES.

Postage on volumes mailed	$ 2.98
Stamps	.50
Interest on loan of $400.00, January 1, 1928, December 30, 1928	24.00
Cash to reduce loan	75.00
Balance on hand	13.13
Total	$115.61

There is a balance due on loan to pay for printing volume II of $325.00.

Respectfully submitted,

J. J. DAVIS, *Treasurer.*

On motion the report was accepted, subject to the approval of the Auditing Committee.

REPORT OF THE AUDITING COMMITTEE.

We, the Auditing Committee, have examined the books of the Thomas Say Foundation, The Entomological Society of America, and the Managing Editor of the Annals, and have found them to be correct.

Respectfully submitted,

CARL J. DRAKE, *Chairman*,
B. A. PORTER,
J. S. HOUSER.

On motion the report was accepted.

REPORT OF THE RESOLUTIONS COMMITTEE.

Your Committee on Resolutions begs leave to report as follows:

1. That we express our appreciation to the local committees for the New York meetings, especially the local committee for the entomologists, which is composed of Wm. Moore, W. T. Davis, H. B. Weiss, E. P. Felt and F. E. Lutz, for their excellent arrangements, equipment and entertainment provided for this meeting.

2. That the Society has felt a distinct loss in learning of the death during the year of the following members: E. A. Schwarz (Honorary Fellow), G. E. Bensel, Juan Brethes, C. L. Fox, Chas. W. Howard, Jacob Kotinsky, and Jerome McNeill.

3. That the Society desires to thank the National Academy of Science for a grant of $500.00 for the publication fund for research papers in the Annals of the Entomological Society of America.

4. To express our deep appreciation for the $1,000.00 presented to the Society from the estate of Mary E. Soule, sister of the late Caroline E. Soule, an honored member of the Entomological Society of America during her life. This is an excellent example which has been set us as entomologists interested in and working for a better Society.

5. That the Society desires to express at this time, on the occasion of the resignation of Dr. Herbert Osborn as Editor of the Annals, its sincere appreciation for his successful and untiring services as Editor, for the past 21 years, of the official publication of the Society, and for the fine progress made in both size and quality of the publication during this time. Further, to express our appreciation to Dr. Clarence H. Kennedy, who now becomes Editor of the Annals, for his faithful assistance to the Editor for the past few years.

Respectfully submitted,

D. M. DELONG, *Chairman*,
J. M. ALDRICH,
P. B. LAWSON.

By vote of the Society the report was accepted.

REPORT OF THE NOMINATING COMMITTEE.

The Nominating Committee beg to report the following names as nominees for the respective offices for the year 1929:

President—C. T. BRUES.
First Vice-President—H. B. HUNGERFORD.
Second Vice-President—LAWSON CAESAR.
Secretary-Treasurer—J. J. DAVIS.

Additional Members of the Executive Committee—For term expiring December 31, 1931—W. T. DAVIS and E. O. ESSIG. For term expiring December 31, 1930, vice C. H. KENNEDY, H. OSBORN.

Councillors to the American Association for the Advancement of Science—W. A. RILEY and C. L. METCALF.

Respectfully submitted,

FRANK E. LUTZ, *Chairman*,
E. P. FELT,
H. OSBORN.

On motion the report was accepted and the Chairman of the Committee instructed to cast a ballot for the election of the persons nominated. This being done, they were declared elected.

The Committee on Collections of Insects in American Museums then reported as follows:

REPORT OF THE COMMITTEE ON COLLECTIONS OF INSECTS IN AMERICAN MUSEUMS.

In continuance of the plan of securing data concerning the progress of the various national and state collections of insects, a request was sent to sixty institutions known to maintain collections, including some such as those at Harvard, Boston Society, Carnegie Museum at Pittsburgh, Field Museum of Chicago, which though not state collections are public in character.

From the replies received the following summary and extracts are presented; it may be noted that a number of reports from collections not hitherto reported are given at greater length and that by referring back to previous reports, (Annals, Vol. XX, p. 140, and Vol. XXI, p. 162) one may find quite complete record of the contents of the different collections.

Dr. Aldrich, for the United States National Museum, reports that "The work on the labeling of the Casey Collection of Coleoptera has continued steadily through the past year. Mr. L. L. Buchanan has put half of his time on this project, which is supported by Mrs. Casey. The work is now about three-fourths completed. Several visiting specialists in Coleoptera have made critical examinations of portions of the collection and all expressed high approval of the installation and labeling which have been adopted. Types recorded to date, 6,382.

"The C. F. Baker collection of Philippine and other Oriental insects mentioned last year, was safely received in the National Museum and comprises about 300,000 specimens, being the largest single collection ever received by the Museum.

"The Bureau of Science, through Dr. R. C. McGregor (in the Philippines), also donated to the Museum, in continuance of its policy, a shipment of over 34,000 undetermined Philippine insects.

"Rev. D. C. Graham, of Suifa, Szechuen, China, has continued to collect actively for the Museum and recently sent over 1,700 specimens, bringing his total contribution for the year to 2,572 insects.

"In the fiscal year ending June 30, 1928, one hundred and six papers, by sixty authors, were published, based wholly or in part on National Museum collections. This report also shows a total number of specimens accessioned of 2,698,692, and 42,524 recorded as types."

For the University of Colorado collection, Prof. Cockerell writes: "We have a good collection of fossil insects, with many types, in the University of Colorado Museum. We keep only a general reference collection of recent insects, primarily for class use. All types except bees have been sent away, mainly to the U. S. National Museum. I have in my personal custody a large collection of bees, for use in my work on this group. Many types (especially of *Osmia*, *Halictus*, *Nomada*, and *Megachile*) have been sent to U. S. National Museum. The others will mostly go there eventually, but some (of Australian species) will go to Australia. Types are not loaned."

Mr. Mutchler, for the American Museum of Natural History, says: "Since our last report the following collections containing one thousand or more specimens have been received by the American Museum: The Lewis B. Woodruff collection of about 26,000 specimens of all orders, including his valuable collection of Membracidæ, containing most of his type material; Barnum Brown, about 3,500 specimens of all orders from Abyssinia; Whitney South Sea expedition, about 1,000 specimens of all orders from the Solomon Islands; Ladew Expedition, about 1,000 specimens, chiefly Lepidoptera from Bolivia; Frank Johnson, about 1,000 specimens, including many of the rarer forms of Lepidoptera; and a large number of specimens collected by Messrs. Curran and Watson at the Department's Station for the Study of Insects."

For the University of Nebraska, Mr. Swenk says: "In the report of the committee on Collection of Insects in the American Museums for 1926 (Annals Ent. Soc. Amer., XX, p. 146) in the paragraph relating to the University of Nebraska Collections, beginning the seventh line from the bottom of the page, the text should read as follows: 'Bruner's types of exotic *Orthoptera;* Williams, types of Aphididæ; Hunter's, Swenk's and Wehr's types of *Diptera;* Dawson's types of Coleoptera; and Crawford's, Swenk's and H. S. Smith's and C. E. Mickel's types of *Aculeate Hymenoptera* are well represented in the collection, which also has numerous types of sawflies described by Rohwer, of bees described by Viereck and of cicadas described by Davis.'

"During the year 1928 Mr. A. F. Satterthwait, of Webster Groves, Missouri, identified the Nebraska Collection of *Calendra*, finding several new species. This collection has been incorporated into the reference series. Also, Mr. P. H. Timberlake, of Riverside, Calif., has furnished through exchange a number of the bee genus *Perdita*, new to Nebraska collection, including paratypes of *P. isocornæ*, *P. quadripunctata* and *P. luteipes*. Mr. J. W. Brown has kindly donated paratypes of his *Onthophagus knausi*. Two friends of the Department have donated small but very interesting collections of Philippine and Sumatran butterflies. Mr. O. S. Bare is rearranging the entire collection to conform with the most recent check lists, and transferring the same to new drawers and cabinets."

The California Academy of Sciences replies as follows: "With the exception of a few types, the collection of insects in the California Academy of Sciences was entirely destroyed by the earthquake and fire of 1906. The present collection, therefore, has been accumulated since that time. It now numbers something over 750,000 specimens. The following are some of the principal units of which it is composed: The central collection of the department is a large item and consists of material taken by the present curator and his assistants. Very extensive material presented to the Academy by Dr. E. C. Van Dyke (excepting Coleoptera), by Dr. F. E. Blaisdell. Sr., Mr. C. L. Fox, Mr. L. S. Slevin, Dr. E. H. Nast, Mr. W. M. Giffard, and numerous other friends of the Academy. This unit also includes the insects taken by the Academy's expedition to the Galapagos Islands in 1921, to the islands of the Gulf of California in 1921, to the Revillagigedos Islands in 1925, and to Arizona in 1924. Collections presented to the Academy include the following among the larger units: The W. G. Wright collection of Lepidoptera, including the plesiotypes of his West Coast Butterflies; the J. G. Grundell collection of Lepidoptera, largely exotic; the E. J. Newcomer collection of Lepidoptera, 1,737 specimens; the F. X. Williams collection of Lepidoptera, 7,662 specimens; the W. M. Gifford collection of California Hemiptera, 1,964 specimens; the R. H. Stretch collection of Bombycine moths, 3,146 specimens; the E. C. Van Dyne collection of Chinese insects (excluding Coleoptera), 3,737 specimens; the A. J. Basinger Alaskan collection, 2,210 specimens; the B. Preston Clark collection of Sphingidæ from the Hill Museum, 567 specimens; and the Henry M. Holbrook collection of exotic butterflies, 500 specimens. In addition to these, five larger collections have been presented to the Academy that are now being incorporated with the main collection. The estimates for these are well within the probable numbers. These are the E. C. Van Dyne collection of Coleoptera, estimated as 150,000 specimens; the F. E. Blaisdell collection of Coleoptera, estimated at 100,000 specimens, and the L. S. Slevin collection of Coleoptera, estimated as 25,000 specimens. In all these figures mounted material only is

included. The collection of type specimens includes holotypes and allotypes only and numbers 2,468 specimens as far as listed. These types are segregated in special metal cases. E. P. Van Duzee, Curator."

Nathan Banks, for the Museum of Comparative Zoology, reports: "The most important addition is the collection of Diptera of Mr. C. W. Johnson. This contains about 30,000 specimens, over 6,000 species, and 545 types. The far greater part is the U. S. collection, but there is a large European series, considerable amounts from Tropical America, and some from Java, Africa, etc.

"There has also been purchased the Arthur Loveridge collection of English insects, largely Lepidoptera. Dr. W. M. Wheeler has presented his Aculeate Hymenoptera, over 20,000 specimens, largely bees. It is mostly from the United States, but there are some from Central and South America, and Australia. During the year over 30,000 specimens have been added by the mounting of material found last year in storage rooms. The changes to make collections more accessible have been enormous. A hall room was floored over for the entomological library, the third or gallery room is being floored over, electric lights installed throughout, cases were built for 1,200 drawers, 200 new drawers have been delivered, and 1,000 more ordered, new cases for alcoholics and fossil insects also were made, and alcoholic insects are being put in double trays."

The Brooklyn Museum of Arts and Sciences reports: "The reference collection of Lepidoptera, exclusive of Microlepidoptera, is at present contained in 947 drawers. Its composition is as follows: Rhopalocera; Nymphalidæ, 9,556; Lemoniidæ, 652; Lycaenidæ, 2,687; Pieridæ, 2,562; Papilionidæ, 1,794; Hesperidæ, 2,524. Total, 19,775. Heterocera Superf. Saturnoidae, 1,141; Noctuidæ, 17,257; Other families (est.), 28,000. Total, 66,173. There are 322 types among the Noctuidæ and approximately the same number in all other groups, making an estimated total of 650. There are very few types among the butterflies. The types, almost exclusively represent North American species. The basis of the collection is the Neumoegen collection, acquired by purchase 1900. To this was added by gift the E. L. Graef collection, a number of smaller collections of more or less value, and the numerous specimens acquired by Museum expeditions to the West and Southwest. The only recent important accession has been the Archibald C. Weeks collection, numbering some 10,000 specimens. A very complete collection of Macrolepidoptera from Long Island, is kept as a separate unit.

The collections of Lepidoptera have been under the care of Jacob Doll from 1897 to 1927, when he retired at the age of eighty. Since then Chas. L. Pollard has been in temporary charge. The Long Island collection has been assembled by Geo. P. Engelhardt. Reference collections other than Lepidoptera are in charge of Chas. Schaeffer since 1902, and their present standing, in large part, represent his efforts in Museum expeditions, local field work and exchanges. Only North American species are included.

Orthoptera	1,400	Specimens,	6	types,	2	paratypes
Neuroptera and Odonata	1,200	"	5	"		
Hemiptera-Heteroptera	2,000	"	6	"	2	paratypes
Diptera	2,200	"	20	"	11	"
Hymenoptera	2,500	"	18	"	4	"
Homoptera	800	"	2	"	12	"
Coleoptera	17,000	"	420	"	9	"
European Coleoptera	10,000	"	obtained by purchase			

"In addition to the reference collections, The Brooklyn Museum maintains collections for public exhibition dealing with classification and various features in biology, ecology and economics. These exhibits are subject to changes, keeping step with current developments in entomology."

The University of Arizona reports: "A small but steadily increasing collection of insects, chiefly from Arizona. Facilities being somewhat limited and the state very large and of very diverse character, collecting work is being practically confined within state boundaries. The general collection totals at least 15,000 specimens, representing several thousand species, since space does not

permit of large series of duplicates. Specimens are housed in Schmitt boxes and glass top drawers. The order Coleoptera is best represented, by more than 700 species, well classified and arranged. In the Homoptera the collection is good. The family Miridæ is represented by well over 200 species, classified by specialists, and including many paratypes, topotypes, and autotypes. Systematic work on the Coccidæ is being pushed and 119 species have been carefully prepared and classified. In the Hymenoptera the south-western family Mutillidæ is well represented, the species determined by specialists. The Orthoptera number above 1,000 specimens, including more than 100 species determined by specialists. We are anxious to co-operate on any reasonable basis with specialists who will determine material. Charles T. Vorhies, Entomologist."

For Utah, Professor Pack writes: "At the present time this collection includes about 45,000 pinned insects and more than 7,000 slides of soft-bodied insects, mostly aphids.

"The pinned insects are distributed as follows:

	Total	*Determined*
Orthoptera	7,000	6,000
Diptera	8,526	1,897
Hymenoptera	8,390	1,624
Coleoptera	12,418	3,622
Hemiptera	5,194	813
Homoptera	1,842	684
Odonata	177	0
Neuroptera	166	8
Plecoptera	126	7
Miscellaneous	1,500	
Total	45,339	14,655

"Included in the Orthoptera is the Henderson collection of nearly 5,000 specimens, most of which are determined, and which includes approximately 300 species. The collection of soft-bodied insects includes 6,500 slides of aphids comprising the Knowlton collection in which are included 400 species. Although most of this collection is made up of Utah material, several hundred slides show aphids from Idaho, northern Arizona, Ohio, Minnesota and other states."

Professor Mote, for the Oregon State Agricultural College, reports: "The insect collection at Corvallis, Oregon, available for use of members of the Entomological Society of America, comprises some 60,000 specimens, mostly in the Orders Diptera, Hymenoptera, Hemiptera, Coleoptera, Lepidoptera and Orthoptera. There are in the collection 2,200 named species and probably 15,000 specimens of Coleoptera, being particularly strong in western species; 450 determined species of Hymenoptera, and 12,000 specimens, many undetermined; 648 determined species and 4,500 specimens of Hemiptera-Homoptera; 794 named species and 8,800 specimens of Diptera, many undetermined; 800 determined species of Lepidoptera, 120 of which are Aegeriidæ from all parts of America, Europe, North Africa and Japan, and 15,000 specimens.

"Many of the species collected have not been determined. The collection is not regarded as a museum collection, being rather one of our tools, somewhat like our collection of special literature on entomology and our other laboratory equipment. The foundation of the collection was a set of duplicates sent me from the University of Illinois when I came to this institution in 1889, but most of the species are now represented by Kentucky examples and many others have been added from this State." H. Garman.

T. H. Frison, for Illinois State Natural History Survey, reports: "The insect collection of the Illinois State Natural History Survey has continued to grow as a result of collecting by the survey staff in various localities in all parts of the state. During the past year some 3,000 miscellaneous pinned specimens and 500 vials of specimens preserved in alcohol have been added to the series. In addition, special efforts were made to build up the Illinois series of stone-flies

and plant lice. This resulted in some 5,000 slides of Illinois species of plant lice being made in the field from fresh material and added to the slide series. The collection of stone-flies, particularly the winter species, was practically doubled by the addition of some 2,000 specimens preserved in alcohol."

In Hawaii, "Insects in Bernice P. Bishop Museum are largely from regions in and around the Pacific Ocean. At present the most extensive collections are from Hawaii. These include a portion of the specimens collected by R. C. L. Perkins and described in the 'Fauna Hawaiiensis.' Among these are many paratypes. They represent about half the species enumerated in that monograph on the Hawaiian insects. About 25,000 Hawaiian insects of more recent collecting are also mounted and largely identified. There are also specimens from the small outlying islands of the group. A large Samoan collection has recently been worked up in connection with the publishing of 'Insects of Samoa,' by the British Museum. There are a number of specimens from Fiji, New Caledonia, Solomon Islands, New Zealand, Austral Islands, Phoenix Islands, Tokelau Islands, Cook Islands, Society Islands, Palmyra, Fanning, Wake, Guam, and other parts of the Pacific. From Australia there is a large collection, formerly belonging to Richard Helms. This has been augmented by specimens collected by J. F. Illingworth, G. F. Hill, and others. On loan are collections from Australia, Japan, China, Guam, Malay Archipelago, Africa and North America." E. H. Bryan, Jr., Curator of Collections.

Professor Haseman, for the University of Missouri, says: "During the year miscellaneous collecting work had added thousands of specimens to our working collection and during the year we have worked over and entered into the permanent collection a great deal of new material in the orders of Orthoptera and Lepidoptera. We have an excellent working collection primarily for the benefit of under-graduate and graduate students. Our permanent collection is primarily housed in the so-called Comstock cases and it includes 31 cases of named and 17 cases of unnamed Diptera, 36 cases of named and 9 cases of unnamed Orthoptera, 27 cases of named Hemiptera, 19 cases of named and 9 cases of unnamed Homoptera, 49 cases of Coleoptera named and 26 unnamed, 103 cases of named Lepidoptera, 44 cases of unnamed; 11 cases representing Mimicry and 40 cases of strictly educational material, 27 cases of unnamed miscellaneous collections and 20 Schmidt boxes of miscellaneous collections."

The collection of the Department of Economic Entomology of the University of Wisconsin consists of about 75,000 pinned specimens, representing mostly Wisconsin's insects. The majority are named, particularly the Coleoptera, which contains an excellent series of flea beetles, the Lepidoptera, Orthoptera, Diptera, Hemiptera and Homoptera. The collection also contains excellent series of plant material, injured by insects, both dried and preserved in liquid. There are, in addition many vials of alcoholic specimens." C. L. Fluke.

The Cornell collections have been enriched by a collection from Surinam by W. T. M. Forbes and P. P. Babiy, and of dragon-flies from China, by Dr. Needham. Other institutions have reported the usual accretions from routine work, or that no outstanding additions have been made.

(Signed) HERBERT OSBORN, *Chairman*,
CHAS. W. JOHNSON,
E. C. VAN DYKE,
J. G. NEEDHAM,
Committee.

On motion of J. M. Aldrich, it was seconded and carried that, "a permanent committee of three be appointed, this committee to be known as the Historical Committee, the purpose of which shall be to commemorate the American Entomological Pioneers, this committee to have authority to solicit funds for the purpose and shall report annually to the Society."

In addition to the regular program the following exhibits were submitted:

1. Pure Chitin and Some of its Derivatives, by F. LESLIE Campbell, U. S. Bureau of Entomology.
2. Pests Injurious to Cultivated Mushrooms, by CHARLES A. THOMAS, Pennsylvania Agricultural Experiment Station.
3. Tracheations in Newly Hatched Ephemerid Nymphs, by MILDRED C. B. PORTER, Mt. Holyoke College.
4. Mid-Intestinal Gland of a Beetle Larva, by WILLIAM C. WOODS, Kent School.
5. Aleyrodidæ of the World, by H. L. DOZIER, Delaware Agricultural Experiment Station.

Fifth Session, Friday Evening, December 28th.

The Annual Public Address was given at this session by Dr. Royal N. Chapman, on the subject, "The Potentialities of Entomology."

Sixth Session, Saturday Evening, December 29th.

The Annual Entomologists' Dinner was held in the Flying Bird Hall of the American Museum of National History.

Respectfully submitted,

J. J. DAVIS, *Secretary.*

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* Deceased.